TRAFFIC QUARTERLY

AN INDEPENDENT JOURNAL FOR BETTER TRAFFIC

JANUARY 1949

Public Spirit
State Police Forces
A Shopping Area Is Saved
Cities Need Traffic Engineering
Landscaping Helps Traffic Safety
Right Turns at Urban Intersections
Economic Analysis for Traffic Trends
Signal-Timing to Meet Traffic Peaks
Business Needs Traffic Engineering
San Francisco's Traffic Planning
Traffic Design of Garages

THE ENO FOUNDATION FOR HIGHWAY TRAFFIC CONTROL

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Public Spirit: An Editorial

THERE are many examples of public-spirited support of worthy city, town and national organizations. Indeed, they are generously aided, their worthiness fully recognized. Few citizens are not either givers or receivers—contributors to them or beneficiaries of their great aid.

Such worthy movements are generally highly organized, free of political bickering or partisanship, and free of discrimination in ministering to those in need. Not all are charitable, but all are examples of efforts whose success, in large measure, is due to national or community spirit.

Two years ago a conference was called in Washington, attended by heads of states and other governmental subdivisions and organizations. The conference was called at the direction of the President for the purpose of organizing on a national basis our efforts to meet the traffic problem that was becoming increasingly and alarmingly disastrous in loss of life and property. Some good has come of this conference but many of the obstacles to marked progressive improvement have not been removed. National understanding and unification of effort have not been achieved.

No one group is to be singled out as slow in its thinking or backward in its progressiveness, though many are floundering in misdirected efforts or a passive attitude of laissez faire.

All appear to recognize the problem. Too many sit waiting for others to solve it.

Individuals and groups, while fully aware of corrective needs and often the most blatant in their cries of despair, are the first to rise in coordinated efforts of strongly organized methods to oppose any suggestion remotely affecting their status quo. They are characteristic of the diehards and do-nothings in civic progress or community building.

They become indignant when a suggested idea conflicts with their outmoded lines of thought.

Conservatism gives needed balance, but lack of cooperation

through selfishness or uninformed thinking adds to the complexity of progress.

Our problems in sociology and the tragic consequences of motor driving on our highways have points in common. Our public-spirited approach to solutions in sociology may well be studied in our approach to the problems of sociologically significant damage and death in traffic.

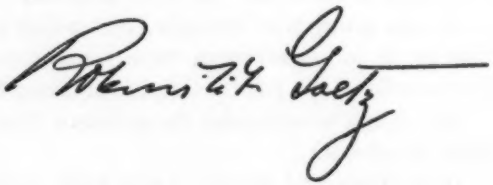
Without compulsion or fear but through the benevolence and generosity of public-spirited citizens—through social-mindedness—we stand ready to relieve suffering from death, illness, injury or disaster, and to submerge, when necessary, some of our individual conveniences in the interest of general welfare.

It is a tenet of our people.

While a searching analysis of the traffic problem continues and long-range corrective needs are being put into effect, our greatest contribution and one immediate in effect is making the best of what there is.

Greater appreciation and cooperation should come from those so vitally interested.

The motoring public should be quick to assume this national obligation.



State Police Forces

COLONEL JONATHAN H. HARWOOD

Colonel Harwood served for twenty years as Executive Officer and as Superintendent of the Rhode Island State Police. He retired in 1946. During and after World War I he served in the Field Artillery in various grades from private to colonel. In 1945, on assignment from the War Department, he organized and inspected German police in the United States Zone of occupation. Later he assisted in organizing and training the U. S. Constabulary in Germany, serving as Police Advisor to the Commanding General. He wrote "Trooper's Handbook," the basic training manual of the U. S. Constabulary.

THE FIRST half of the twentieth century has witnessed the inception and growth of the two great institutions that have exerted a marked and beneficial influence on law enforcement in the United States: state police and the Federal Bureau of Investigation. This article deals with state police. Its object is to discuss the nature of state police forces, and to point out reasons for their many successes and occasional shortcomings.

The automobile, with its attendant problems of crime and traffic, has been a major reason for the creation of the State Police and State Highway Patrols which now exist in one form or another in all of the states.

The outstanding exception to this primary cause of origin is the Pennsylvania State Police, organized in 1905. This oldest organization of state police in the country made its patrols on horse-back long before motor vehicles and hard roads were common. It is proper to record that the Pennsylvania State Police has carried the banner well, and has set an inspiring example to the younger forces, several of which have made enviable records and attained well-deserved fame in their own right.

States have inherent police powers guaranteed by the Federal Constitution. The fact that they have delegated local police powers to their political subdivisions (counties, cities, townships) has not impaired the authority of the states to assume and exercise their

primary police responsibilities whenever they deem it wise to do so. This assumption of long-dormant authority has not proceeded along uniform lines. Many states have acted timidly or hesitatingly. In general, states that were among the first to create their own state police forces acted with the greater courage and passed basic laws giving their state police broader powers than did states that entered the field later. Generally speaking, these older forces have given a higher quality of service under less restrictive laws.

The term State Police is sometimes used to denote all police forces that operate directly under state authority and generally throughout their respective states, as distinguished from county, city, and township police, whose areas of jurisdiction are limited to their respective political subdivisions. One finds a fairly wide range of authority, however, among the several state forces. Some are limited primarily to patrolling state highways and the enforcement of traffic regulations thereon. Others have broad general police powers over all types of crime as well as traffic, and extending to all parts of the state. Many have powers that lie between these two extremes. Even state forces with the broadest powers habitually refrain from exercising their authority in cities, unless directed by the governor to do so. Occasions arise when the local police are unable or unwilling to act, and under these circumstances the governor and the state police are obliged to intervene. Such selectivity in the exercise of authority is often a practical recognition of the relatively small size of the state force and the constant need for its services in large rural areas, where adequate protection would otherwise be lacking. But sometimes it is due to restrictions imposed by political considerations.

Political Pressure Brought Highway Patrol

County and city politicians, and especially county sheriffs, fearful of infringement of their police (and political) powers, have furnished much opposition to the creation of real state police forces with broad powers over crime and traffic. The resulting compromise has often been the State Highway Patrol. This, as the name suggests, operates only on major thoroughfares and usually confines its operations to traffic control. As time passed and the public became con-

vinced of the greater economy and efficiency to be had, some of these restricted forces were granted broader powers and have approached the status of true state police. The situation has never been static.

A few states have experimented with both a state police and a state highway patrol, the latter existing solely for traffic enforcement, while the former concentrated on crime. In no state has this experiment been completely successful. It cannot be justified on sound grounds. Crime and traffic are not mutually exclusive, nor subject to strict compartmentation. They are closely interwoven. Creation of separate state forces to handle these functions is comparable to hiring two men, each with only one arm, to do a job that one man with two good arms can do better. Such experiments sometimes result from a bit of "empire building" on the part of a state motor vehicle administrator, but may also occur if the state police neglects its traffic responsibilities. Where the latter is the case, the proper cure is a vigorous correction of the state police deficiency, rather than to accept it and set up dual authority. Political expediency does not justify a cure which is worse than the disease, which gives results incommensurate with the cost, and which invariably produces interdepartmental jealousies. Apologists may claim perfect cooperation between the two forces, but cooperation is seldom a satisfactory substitute for unified command.

While state forces vary widely in jurisdiction and numerical strength, they have at least one common problem. For most of them it presents a major challenge every day of their existence, and one that grows year by year. That problem is traffic. Many of them must also contend with crime of all types. To meet these responsibilities, the police of this country have more equipment than any police in the world.

State forces are generally well equipped. They have first-class motor vehicles, firearms, radios, teletypewriters, lie-detectors, cameras and a host of other items. Crime laboratories, medico-legal experts, and airplanes are available to them. America loves tools. The police have, and effectively use, their full share. This is as it should be, but in this highly technical and motorized age, one sometimes notes a tendency to minimize the prime factor, man himself, and to over-emphasize the virtues of physical equipment.

Police executives are sometimes prone to forget that all these scientific aids, valuable as they are, are merely extra strings to the official bow. The extent to which they exist is no final criterion of efficiency. In an age of horses and muzzle-loaders, Napoleon declared: "In war the spiritual is to the physical as three is to one." In the never-ending war on crime and traffic that pronouncement is still valid. Man is still greater than the machine.

Leadership Built Strong State Police

The early state police forces, though having to overcome great obstacles, started from scratch with one mighty factor in their favor: they had no politics-ridden past to live down. They had no tradition. It was up to them to create one. The shield was clean. They were determined not only to keep it clean, but to give it a polish.

This was accomplished—in some cases to a superlative degree. It was brought about by leaders of character, vision and determination. Their methods were: Painstaking selection of a high type of personnel; thorough training; rigorous discipline; and careful supervision. It was as simple as that, but it entailed endless labor, constant vigilance to guard against encroachment of insidious influences, moral courage to oppose meddling politicians, and never losing sight of the goal. It will always be as simple as that—when men of that type are given command. State police, like military units, reflect their leaders.

The basic law creating a state force and defining its powers is obviously of major importance. Some of these laws have been broad and farsighted, reflecting careful thought and competent advice. Others reflect a timid approach, an easy satisfaction with mediocrity, or a desire for political control. In some cases unwise amendments have weakened the law. Timidity and mediocrity cannot produce a state police worthy of the name. Political control is ruinous.

Important as the basic law is, it still is less vital than the quality of the commander and his personnel. Good men will find a way to make a poor law work, but the best law in the world is of little avail if administered by inferior men. It is said that when Colonel John C. Groome, first Commissioner of the Pennsylvania State Police, was

asked what kind of law was needed for a new force, he replied: "Give us a simple law with broad powers. A good man will need all the rope you can give him. A bad man will hang himself with it that much sooner."

It is axiomatic that the commander should have broad powers of appointment, promotion, discipline and discharge. How else can he be held responsible for results? If it be argued that this is too much power for one man to have, the answer is that the best forces have it. It is practicable to include moderate provisions to prevent arbitrary abuse of power.

One of the most valuable provisions of a basic state police law is one that requires all police personnel below the commander to be enlisted for terms of two or three years. This clause is found in the laws of several states. The great advantage in such a provision is the opportunity it gives to eliminate mediocre personnel by refusing them re-enlistment. Upon expiration of the term of enlistment, the commander can give an honorable discharge to the man who is unsuited for state police duty, but whose conduct is good and who never gives cause for a disciplinary discharge.

This eliminates the man who lacks ambition and energy, the time-server who would be protected forever by Civil Service. It keeps all men on their toes. They feel that they must make good continuously, if they want to stay in the service. It is perhaps the greatest single, legal protection against mediocrity. Unfortunately some state forces which have this provision in their law, neglect to use it to eliminate human deadwood. The demands of state police service are so severe that no force can afford to carry deadwood. Failure to invoke such a provision of the law, when clearly called for, must be attributed to lack of moral fibre in the commander.

Training Plan for State Police

It is normal for state forces to undergo rigorous recruit training before sending their men out to enforce the law. The quality and duration of training varies among the several states. In general it is adequate. In some states it is remarkably thorough. Refresher training is given in many forces. Refresher schools provide re-training, intro-

duce new police techniques, and help to insure uniformity of procedure throughout the force. Otherwise, men get into wrong habits and easy-going ways, and the service deteriorates. Advanced and specialist schools in some forces provide valuable preparation for promotional examinations and specialized service.

Both recruit and refresher schools customarily lay emphasis on discipline. That is well, but every-day service shows considerable variation in the visible evidences of discipline. Some forces have neglected to maintain their original standards in this and other respects. Others have displayed a marked improvement shortly after a new commander took office.

A few commanders have stated that they did not believe in strict discipline, but the best forces have it. Lack of it is invariably reflected both in appearance and in performance of duty. There is no substitute. In state police service it is not enough to BE GOOD, you must also LOOK GOOD. A Regular Army captain once remarked to a state police officer: "Your outfit is more military than the Army." To which the latter replied, "We have to be. With us the war is on all the time."

Americans outwardly resent discipline, but secretly respect it and approve of it. No good trooper or soldier wants to belong to an undisciplined organization, yet they often gripe at discipline. Failure to understand this apparent contradiction, and to take the trouble to maintain proper discipline, has brought grief to police and military commanders who should have known better. Lack of discipline is evidence of weakness and inefficiency. The pay-off comes when a mere handful of police must control a rioting mob. Without discipline the police are licked, and vital prestige is lost.

Having carefully selected and trained his recruits, having inculcated pride, discipline and (he hopes) good judgment in his subordinates, the commander of state police sends them forth to enforce the law without fear or favor. He is now up against the problem of everlasting supervision and eternal vigilance to insure the maintenance of those high standards, which he and his predecessors have established for the force. He soon learns (if he didn't already know it) that nothing can be taken for granted, and that even well-trained, experienced troopers, non-coms and officers need to feel that the

"Old Man" is everywhere and sees everything. Human nature being what it is, he knows that once in a while (fortunately seldom) an old and trusted subordinate will let the outfit down. Occasionally someone will violate regulations. These things cannot be overlooked, not even the minor infraction.

The commander also finds that one of his main problems is to develop good judgment in his subordinates. No set of regulations, however complete, can cover all situations which will be encountered. His men, more often than not, operate far from their headquarters. They must make decisions on their own responsibility. Therefore they are taught principles, illustrated by actual and hypothetical cases. Their actions and decisions are reviewed by seasoned officers and non-coms. When a mistake is made, a memo is published to the force, giving all pertinent facts (except the trooper's name), so that all will understand the reasoning involved. Honest mistakes will occur, but the danger of repeating the same mistake is minimized. All men profit by the experience of all others. Praise, when deserved, is as freely awarded as censure.

The Future of State Police

All of these devices and methods have contributed to the success of state police forces, and to the generally high esteem in which they are held by the public. It is apparent, however, that a considerable disparity exists among them. Some state police compare favorably with the best police in the world. The average, from coast to coast, is good. The state police movement, now in existence for over forty years, has built a fine tradition of courageous service and unselfish devotion to duty. It has exerted a tremendous influence, by deed and example, upon American law enforcement. It has come of age. What is the outlook for the future?

Answers to that question may differ widely. Generalizations are risky, but certain dangers are readily discernible. These can be avoided, if determination to do so exists. Otherwise, the golden age of state police may prove to have been in the past rather than to lie in the future.

These dangers are not new, but they are persistent and must be

fought all the time. Therein lies their greatest threat. They cannot be conquered and forgotten. Major dangers are four:

1. Failure to maintain the highest possible standards in personnel and performance.
2. Deterioration of discipline.
3. Civil Service control over personnel.
4. Encroachment of political influences and control.

The first two of these are the clear responsibility of the commander of each force. If he has the required character and competence, there is no insuperable difficulty.

The third danger, Civil Service, represents a well-meant, but mistaken, trend found in some quarters. Civil Service has its proper place, but not here. State police have repeatedly demonstrated that they can produce results far superior to the best that Civil Service has ever produced in the United States. To place them under its control would almost certainly reduce the character of state police service to that of a mere job on the public payroll. Civil Service, as it operates in this country, too often places a premium on mediocrity and a ceiling on initiative. It tends to smother the spark.

This logically brings us to the fourth and greatest danger: political influences, the curse of most county and municipal police. It must be admitted that some of the state forces, to some extent, have already succumbed to this evil. Herein lies the strongest argument for Civil Service, as the lesser of two evils. Is there no other alternative? Must a choice be made between Civil Service and political control?

The crux of the problem lies primarily with two individuals in each state: the appointing authority (usually the governor) and the commander of the force. Past experience in many states proves that it is entirely possible and practical to have a high-class, impartial, non-political state police. The main requirements are three:

First, that the governor appoint the best man he can find to command the force, regardless of political considerations.

Second, that he allow his appointee a free hand to develop a first-class force.

Third, that he remove him if he fails.

A number of governors have met these requirements, recogniz-

ing the existence of a strong popular feeling that state police should be established and maintained on a high level, removed from political interference and influences. It has happened repeatedly in the past, and with splendid results, encouraging to the people and to students of government. The one great hope for the future of this unique public service lies in the practical acceptance of these principles by those in whom the primary responsibility rests. No magic is required. Nothing less will work.

Highway Landscaping Influences Traffic Operation and Safety

HAROLD J. NEALE

Mr. Neale has been Landscape Engineer of the Virginia Department of Highways since 1930. Besides his duties of landscape operation, he is director of outdoor advertising, of highway zoning, and of traffic sign installation. He is also editor of the Virginia Highway Bulletin. He is chairman of the Committee on Roadside Development of the Highway Research Board, National Research Council, and co-chairman of the Executive Co-ordinating Committee on Roadside Development of the Highway Research Board and the American Association of State Highway Officials. He was formerly Superintendent of Parks and City Forester for Worcester, Mass., and Landscape Architect for New Orleans, La.

More than fifty-three million licensed drivers are using highways in quest of their inalienable rights of life, liberty and the pursuit of happiness. While conditions and opportunities are far different from those of 172 years ago, the purpose is the same—the right of every man to enjoy freedom in religion, business, social and recreational pursuits.

Man, however, cannot obtain complete happiness on highways where he must be constantly alert to avoid danger. When the time comes that every driver does his part with the motto of "Live and Let Live," the growing accident toll will undoubtedly be materially reduced.

Control of the mounting highway accident toll rests in the hands of motor vehicle drivers. Yet, the driver is not always entirely responsible. Records indicate that many accidents have been caused by faulty mechanism that could not have been foreseen. His responsibility is not limited to the actual driving of the motor vehicle. He must, at all times, know the condition of his vehicle and be assured that brakes tires, lights and other vital parts are in good working condition. Once he has a thorough knowledge of driving techniques,

the laws of the road and the condition of his machine, he should be ready to take his place on the highway.

Physically Fit and Mentally Awake

But that is not all. He must be physically fit and mentally awake —alert and ready for any emergency that may arise. The individual, as well as highway departments, should, as a duty, see that everything is done to avoid driver-fatigue.

Highway departments have other responsibilities. Everything possible must be done to eliminate the many and varied road conditions that contribute constantly to traffic accidents. Many highway departments make intensive studies of accident-prone locations and promptly remedy conditions, or at least erect warning signs or signals to warn traffic of danger.

Unfortunately, however, many accidents result from drivers' failing to heed such warnings. All of these precautionary measures are of little or no avail when they are disregarded. A sharp curve, hazardous at legal speed limits, can be negotiated without endangering anyone at a speed commensurate with the curvature. The driver must be able to determine his ability to negotiate a curve without danger to himself or others. This is one place where the responsibility for accidents rests definitely with the driver. Unless he is alert and cautious, he may add to the accident toll.

Landscaping Helps Both Safety and Operation

Causes of highway accidents fall into two categories, the tangible, or evident, and the intangible. By the same token, both tangible and intangible remedial measures can be taken. Highway landscaping contributes to both highway safety and traffic operation.

From the earliest colonial days, courts have upheld laws protecting trees along public ways. Their shade has been welcome to many a weary traveller. Today, even at fifty miles an hour, we welcome the same shade, whether it be from arching trees or through wooded areas. Trees have undoubtedly saved many lives and prevented many accidents in intangible ways. The average driver seldom realizes the

great safety values derived from the shade of roadside trees, until he has been driving over wide, open, barren areas and then comes abruptly to a shaded oasis.

How many times have we driven on an East-West highway with the glaring rays of the sun beating through the windshield. Not only the direct sun's rays but the glare on the pavement often blinds the driver. Well-spaced, arching trees add immeasurably to driving comfort on such highways, while long stretches of wooded areas along the roadsides, whether on East-West or North-South routes, offer welcome relief from the heat and glare of a beating sun. Too much emphasis cannot be given to this important safety feature.

Roadside trees have been accused of contributing to highway accidents. Engineers should carefully evaluate trees that might prove to be hazardous to traffic and if measures cannot be taken to eliminate the hazard they should be sacrificed. In evaluating a roadside tree, consideration should always be given to the specie. Comparatively short-lived trees, or those that are susceptible to storm damage, should not be considered in the same class with the longer-lived and more hardy species. Short-lived trees are usually in the so-called brittle class and should only be used as temporary expedients until such time as the longer-lived or more hardy species can be developed to replace them.

Not only do roadside trees add to the comfort of driving; they make ideal resting places. A picnic table placed under a large spreading oak or elm is inviting at any time during the day and furnishes an opportunity for rest and relaxation under ideal conditions. Roadside tree planting has not been generally practiced, possibly because of the vast amount of basic erosion control work needed on most new construction.

Trees Should Be Saved Whenever Practicable

Many roadside trees have been preserved during highway construction. Many more that would today help reduce accidents have been unduly sacrificed. When it is considered that trees properly spaced along a highway aid in preventing snow-drifting, help keep drivers alert by reducing driver-fatigue, as well as to add comfort

and beauty to the road, it should be apparent that any highway funds expended in conserving or planting trees will pay huge dividends in the future. Trees take years to develop to a useful size.

Shade trees, flowering trees, and shrubs play important roles in protecting the large highway investment, and in promoting safety. They pay dividends in promoting better traffic operation. Many steep slopes susceptible to erosion, and in some cases to dangerous slides, have been protected and stabilized by judicious planting of deep rooted trees and shrubs. Not only has this treatment saved thousands of dollars in maintenance clean-up work, but it has added to driver comfort by reducing the glare from otherwise bare, unsightly areas, and has prevented dust from blowing onto the highway. It is unfortunate that all highway slopes cannot be flattened sufficiently to allow turf-covering. The cost of this in mountainous areas would be prohibitive, but these scars on the sides of the road can be healed if nature is given the least bit of encouragement.

On high-traffic-volume highways where opposed traffic is divided by a wide median, trees and bushy shrubs, when located with precision, will eliminate practically all cross-glare of headlights. This does not mean a continuous hedge or a continuous planting of trees and shrubs, but in many cases these can be echeloned in such manner as to break cross-glare and give the median strip a naturalistic appearance.

Well-Placed Plantings Give Signs Target Value

As long as it is necessary to have traffic signs, every effort should be made to give them the fullest target value possible. A traffic sign silhouetted against an evening sky at sundown is hardly visible on approaching it, while a background of evergreens would help to give it more target value. Similarly, plantings around headwalls, on the back side of curves, and bordering bridge approaches, help materially in defining roadway limitations. Such plantings thereby direct traffic away from these impediments which, under adverse light conditions, are not always readily visible. Such plantings, however, should be carefully watched to see that they do not encroach over the traffic lanes or limit the sight distance.

It has long been the writer's opinion that many warning signs might be eliminated—or, if retained, at least their message greatly amplified—by the planting of trees of the same species uniformly spaced on the outside of curves, at intersecting roads, in front of public or semi-public buildings, and at other places that demand the driver's undivided attention.

For example, a driver may see a curve sign but be unable to visualize the intensity of the curvature or to tell whether or not it is on level terrain or a combination of horizontal and vertical curvature. A row of uniformly spaced and formally developed trees on the outside of the curve would immediately give the driver an idea of both the horizontal and vertical curvature. Were this idea universally practiced, especially at intersections and in front of schools and other public buildings, drivers would soon be accustomed to the need for more alertness and care when approaching such areas. Here again care must be exercised to keep trees and shrubs from interfering with sight distance.

Road shoulders, in many respects, might be placed in the realm of a typical "no man's land." In many cases, material placed on shoulders is anything that the contractor has left over after completing the major parts of his project. Then, in order to hide the appearance of the miscellaneous materials, an attempt is sometimes made to cover them with turf and thus effect a camouflage. Shoulders are vital to highway safety. They are retreats in cases of potential danger and are absolutely essential for opportunities to park on heavily travelled roads to change a tire or make motor repairs.

Shoulder Treatment

Such stops are not confined to dry weather, but may be necessary during prolonged wet spells. Unless shoulders are stable enough to hold up all kinds of traffic under any conditions, they are hazardous. To camouflage hazardous shoulders with turf should be an unpardonable offense for the engineer or whoever is responsible for doing it. Everyone recognizes the value of clean, uniform turf as compared with otherwise dusty, glaring, barren shoulders. Limited research made on this subject indicates that a shoulder properly constructed

and stabilized to maintain normal traffic loads can be successfully covered with turf. It must not be expected that the turf on such areas will be of the "putting green" or "lawn" variety, but will be of sufficient texture to eliminate dust and erosion and define the edge of the pavement.

Roadside techniques developed in the last several years have made it economically possible to eliminate deep, unsightly, gouging ditches. Where the volume and velocity of the drainage water is excessive in either side ditches or those in the median, these ditches should be paved. In other cases, wide swale gutters of adequate depth and width to handle normal water can be turfed. This procedure also adds to the appearance of the roadside and contributes to reducing driver-fatigue. They also offer ideal opportunities for emergency retreat without the danger that has befallen so many drivers when they have had to take refuge in a deep ditch.

While it is a little more expensive to construct a 3 on 1, or flatter, cut or fill slope, the economic savings that result over years in maintenance are usually absorbed. In addition to the economic savings, flat slopes contribute to accident prevention. Steep-fill slopes require guardrail. Many accidents have been averted by guardrail and, by the same token guardrails may have contributed in one way or another to the intensity of some accidents. A driver has more opportunity to save his life and the lives of his passengers by driving over a stable shoulder with swaled gutter and flat slope than to hit a guardrail or drop into a deep ditch.

Wayside Parking Places

Many states have undertaken extensive programs of erecting markers to portray the historical interest of the area. In the past, many of these have been placed along the edge of the shoulder without giving motorists opportunity to stop and read the text in safety. States that set these markers well back from the roadside and build a stabilized, confined parking area, are not only adding to the comfort of the motorists who wish to stop and read them but are adding a safety measure to protect those who stop, as well as those who are passing.

Not only at historical markers, but at other places where motor-

ists wish to stop and view the scenery, should safe and orderly parking facilities be built. There is hardly a time when we do not see heavily ladened trucks parked along the side of the road with their drivers sound asleep. In many cases, these resting places are predetermined in the truck driver's mind, especially those who make routine trips. In fact, many times we notice trucks from different companies parking in the same area.

Where such conditions exist, the state can well afford to develop a safe parking area. At times, these places have been selected without due respect to their location from a safety standpoint. A few hundred yards one way or the other, many times may mean locating them at the top of a hill or on a long tangent where more sight distance is afforded the driver upon leaving. These places can be most unsightly unless properly outlined and surfaced.

A wayside may be a turnout at a historical marker or a parking area at a vista, or it may embrace a larger area. Some states have established recreational areas with valuable opportunities for many groups to congregate for a picnic lunch or for a day's outing. These, although primarily used by local people, offer ideal retreats for tourists. Anything that can be done to make a trip more interesting for the tourist and, above all, furnish places for rest and relaxation, contributes in large measure to highway safety.

Beautification Essential in Highway Operation

The "complete highway" is composed of four prime factors—utility, safety, beauty and economy. Unless the highway is serving usefully and offering services for the enjoyment and relaxation of the motorist, it has no place in a highway system. Whenever the elements that promote safety in every respect are not developed to their fullest perfection, accidents are bound to result. The elements of beauty, although considered by many in the aesthetic category, are as essential in highway operation as they are in architecture, or any other type of construction.

In 1947 there were over thirty-seven million motor vehicles registered in the United States. This was an increase of nearly 10 per cent over the previous year. Each year will show increased production and

improvement in the design of both automobiles and trucks that will prolong their life and increase their use. New automobiles are being built for accelerated speed, while trucks are becoming larger and heavier. The time is fast approaching when highway revenues will hardly be adequate to take care of the maintenance of the highway system. It is, therefore, vitally important that states construct highways that will require the least maintenance. Developed roadsides materially help in protecting this highway investment and in reducing maintenance operations.

The parkway, as its name implies, is designed primarily as a pleasure or recreational route. It embraces all the prime factors of highway construction. Highway engineers are prone to give more consideration to utility, safety and economy factors and let the element of beauty come if, when, and as funds are available. This is not the case in all states. Some that pioneered in roadside development activities have learned that developed roadsides provide not only the element of beauty but also utility, safety and economy.

Accident and Damage Compared

Recently Connecticut reported that users of the Merritt and Wilbur Cross Parkways have better than a six to one chance of avoiding a fatal accident as compared with users of the Boston Post Road, U. S. 1. A comparison of the 43-mile stretch of parkway between the New York State Line and Orange and the 42.7 mile stretch of the Post Road between the same points for a five-year period showed fourteen fatal accidents on the parkway and eighty-eight on the Post Road. The fatalities resulted from 1079 parkway accidents, as compared with 3392 on the Post Road, which gave a rate of one fatality for every seventy-seven parkway accidents against one for every thirty-eight on the Post Road.

In a similar pattern, property damage, as a result of accidents on the parkway, amounted to $255,498, while on the Post Road it was about three and one-half times as much, or $885,579. It is true that the parkway has separated traffic and interchanges at intersecting routes, while the Post Road is a four-lane, undivided route carrying mixed traffic through urban areas where the cross flow of traffic is

on the same level. This indicates strongly that a landscaped highway similar in design and character to a parkway contributes to highway safety and traffic operation.

It is obvious that roadside trees, ground covers, landscape plantings, road shoulders, parking areas and many allied roadside features furnish the driver with either tangible or intangible safety or traffic operation values. Overall, these items are considered a part of roadside development operations. Two decades ago, roadside development was placed in the category of "pansy planting" or incorporating mere aesthetics or beauty in the highway.

Beauty is not measured except possibly by comparison, and therein the human equation becomes the criterion. Things are accepted as being beautiful by one group or an individual and rejected by others. In the last analysis, beauty must be measured by its values or, as has been said, it is the crowning perfection of that which is useful. Natural beauty, when made a part of highway roadsides, whether fundamentally for erosion control or for more intensive categories, furnishes economic, safety and utilitarian value. The pleasing effect of greensward, shade and flowering trees, and shrubs, gives the motorist unconscious relief from glare and unsightliness and reduces driver fatigue. This, in itself, promotes driver alertness.

Acceptance of the premise that control of traffic accidents lies largely in the hands of the driver, the tangible and intangible benefits obtained through highway landscaping will play a part in reducing the present high accident toll. Furthermore, it must be realized that the element of time is most important in nature's processes. Ideal climatic conditions, coupled with ideal soil and landscape techniques, aid materially in helping nature, but an arching tree cannot be developed overnight.

If we are to protect our motorists of tomorrow, we must landscape our highways today.

Signal Timing to Meet Peak Loads of Traffic Demands

HOLDEN M. LEROY

Mr. Leroy has been Senior Assistant Traffic Engineer (traffic signals) for the Detroit Traffic Engineering Bureau since 1943. For two years prior to that, he was Assistant Traffic Engineer for the Traffic Engineering Bureau of the Indiana State Highway Commission. From 1939 to 1941 he was a Traffic Engineering Aide for Portland, Oregon. Mr. Leroy is a Registered Professional Engineer (Indiana) and an Associate Member of the Institute of Traffic Engineers.

SINCE the war the increased traffic on our city streets has brought serious problems of congestion and traffic stagnation. This is particularly true on major thoroughfares of larger cities during the morning and afternoon peak hours. In heavy industrialized areas, these peak hours extend over a considerable portion of the day.

Those responsible for the moving of this mass of population know these facts only too well. What can we do to provide a solution to the problem and facilitate this flow? In most cities we are stuck with our street system with all its inadequacies and must find means to make it work.

Many cities have expressway programs underway to provide long-range relief, but it will be years before this work can be completed. In the meantime something must be done on existing arteries. A great deal can be done with modern traffic signal systems which, although somewhat expensive, can produce considerable beneficial results. The purpose of this article is to point out some of these methods based on experience in the City of Detroit, and Detroit is as heavily motorized as any city in the United States.

Coordination of signals on streets where such intersections are at least as closely spaced as one-half mile, should be considered. The popular conception in the past has been that coordination would not work where signals were spaced much more than 1200 feet apart. Detroit has several spacings of a half-mile or greater where the systems are working quite satisfactorily and where they promote an

orderly and smooth flow of traffic. If it is not financially feasible, it is not necessary to interconnect these signals to a master controller. Efficient operation can be obtained with isolated synchronous control equipment, if its offset-timing is properly accomplished.

Common practice in many places has been to relate each signal in offset to the previous signal throughout the length of the street. There is always a certain amount of error in human reaction in operation of the stop-watch when setting the signal offsets. Often the previous signal cannot even be seen. Under this method, these errors are cumulative along the street and result in a considerable error by the time the end of the system is reached. This is particularly bad for the traffic traveling in the reverse direction to that in which the timing is made.

To overcome this, a system of gongs operated by synchronous timers was installed in the signal shop. A different timer is used for each cycle in use in the city so that the gong can be rung at intervals corresponding to whatever cycle is used on the system in question. All offsets for synchronous controllers are given as so many seconds after the prescribed gong rather than related to some adjacent signal.

This gong can be heard over either Bell or police telephone systems and the stop watch can be started at each intersection on the gong. In this manner cumulative errors are eliminated and split-second settings can be maintained. When it is considered that a vehicle at 30 m.p.h. travels 44 feet each second, good progressive movement depends on accurate timing.

As previously mentioned, one of the chief traffic problems is the differing traffic volumes on a major street at different times of the day. During the rush hours when everyone is either going to or from work, volumes are much heavier and speeds, therefore, lower. Unfortunately most signal systems are capable of only one timing both of cycle split and offset which must be used for the entire twenty-fours of the day.

Flexibility in Time Setting Needed

This sort of system will not satisfactorily handle these varying conditions. If timed to handle the offpeak loads with their corresponding travel speeds, they break down miserably during the peaks.

Volumes are too high to be handled with the green period allotted and speeds cannot be maintained to fit the offset settings. Many stops and considerable congestion result. If the system is timed to fit the peak volumes and lower speeds, the results are bad during the twenty hours or so of offpeak operation. Due to higher travel speeds, stops are required at most signals and a portion of the green period is wasted.

This obviously points to the need for systems capable of flexibility in their time settings. Such are available, some much improved since the war. Although the expense of such a system may appear to be high, the benefits derived on a major artery make it justified. A completely flexible system was installed on one of the most heavily traveled streets in Detroit about three years ago. The system includes sixteen signalized intersections and extends over about four miles of the street.

This street is a typical major artery, 72 feet wide and carried a street car line. Even with parking removed only three lanes were available in either direction. Volumes had reached 45,000 vehicles per day with 2400 in the rush hours in one direction morning and evening. Congestion was very great and average speed slow during these hours.

A modern fifteen-circuit, two-dial, triple offset control with cycle extension features was installed at each intersection. These were interconnected to a master controller and program device so that the various changes in timing could be set up automatically and supervised on a previously determined schedule in order to meet changing traffic conditions. During the base hours of the day, the shortest possible cycle consistent with traffic demands was used, and the signals related to each other along the street to provide as good two-way progression as was possible with the signal spacing.

During peak hours the cycle was lengthened with almost all of the additional time added to the major street green period. In addition, offsets were used so as to provide perfect progressive timing in the heavy direction both morning and evening. This resulted, of course, in poor progressive timing in the reverse direction but with the longer green periods and lighter volumes no serious congestion developed.

Complete before-and-after studies were made to determine the

results of this type of signal system. These included speed and delay studies and observations to determine the number of stops experienced at the various signalized intersections. The "before" studies made in 1945 and the "after" studies two years later in 1947 showed a drop from an average of seventeen stops per vehicle within this system of sixteen signalized intersections, to ten, or an approximate 40 per cent reduction. Some increase in street capacity also resulted.

Since that time, the capacity of the street was further increased by the substitution of buses for street cars and the reversal of direction of travel in the two center lanes during rush hours. The latter results in four lanes in the heavy direction and two in the light direction during each peak hour period. This additional street capacity has made evident the advantages of the flexibility in this timing equipment.

A Satisfactory Final Result

Following these changes and under favorable conditions, it was possible to drive the entire length of the system during peak hours with, at the most, two or three stops. Driving time in a five-mile stretch including this four-mile system was reduced from 21 minutes to 16 minutes. Peak hour volumes have risen since these changes were started from 2400 per hour, mentioned earlier, to a volume of 3508 vehicles per hour in one direction.

A lane density study made at the point of maximum volume on the street showed some surprising figures inasmuch as they were much higher than previously believed possible. The following figures are the number of vehicles actually counted in each lane during the one-hour period. Signal timing allotted 40 seconds of a 70-second cycle to the major street. The curb lane carries buses, which make a far-side stop, and a considerable right turn movement.

Vehicles Passing in One Hour

Curb Lane	*2nd Lane*	*3rd Lane*	*4th Lane*
791	1,013	901	803

The final result, therefore, proved very satisfactory in the reduction of congestion, number of stops and in a general improvement of traffic flow.

Similar results can be expected on any street having similar characteristics. The same type of flexible control can be adapted to streets having heavy rush hour traffic even though it remains approximately equal in both directions through the peak hours.

Detroit has a number of one-way streets carrying heavy volumes where intersectional signals were spaced at quite long intervals. Additional intersectional signals were not warranted as no other one cross street had large amounts of cross traffic. The absence of signals in these long stretches, however, created a number of problems. Traffic tended to string out in these areas as well as to pick up a considerable number of vehicles infiltrating from the cross streets. This made it extremely difficult and hazardous for vehicles and particularly pedestrians to cross in these areas. It also resulted in a large number of stops and considerable congestion at the next signal even though progressive timing was in use.

As a remedy, Detroit installed overhead suspended signals in the middle of the block facing the one-way traffic only. These are placed at about three-block intervals or 1000 to 1200 foot distances and are timed into the system. In this manner the traffic is held in closely defined platoons and is not allowed a chance to spread out. A more orderly flow of traffic results with gaps between the platoons. Thus cross traffic is benefited, speed is controlled and stops and delay reduced. When peak hour volumes are high enough there is value here also in flexible control allowing an increase in cycle length and main street green period.

Desirable Cycle Lengths

In general, experience has shown that the most efficient handling of traffic will be obtained by using the shortest possible cycle consistent with the traffic volumes entering the intersection. Where the signal is operated by a controller not having facilities for timing changes at different times of the day, the cycle and interval splits will have to be those required for peak hours on each street.

In determining the length of total cycle to be used, several factors will be involved. If the signal is not part of a coordinated system, the cycle can be determined by the number of seconds of green interval required to handle the traffic on each street. For normal two-street intersections, a 50- or 60-second cycle is the maximum normally

necessary. Longer cycles result in the green interval appearing less frequently with longer red intervals intervening. This results in building up a larger back-log of traffic during each red interval and less efficient operation on the street.

Where the signal is part of a system coordinated for progressive movement there often is not much choice of cycle which can be used. This is true particularly for systems operating on the same timing 24 hours per day and also for offpeak hour timing on flexible systems. With signal spacing on the street normally fixed and the prevailing speed of traffic subject to little change there usually is only one cycle which will give any satisfactory progression.

Under such conditions, the amount of time required at each intersection to handle cross traffic with due regard to pedestrian crossings should be used for the cross street green period with the balance allotted to the major street.

Numerous studies of lane delivery at signalized intersections in Detroit have indicated the following method to be quite accurate in determining the length of green interval needed to accommodate given volumes. If it is assumed that during the peak 15-minute period traffic is arriving at the intersection at a constant rate, it can be calculated how many vehicles it will be necessary to handle per lane in each total cycle in order to accommodate the volumes using the intersection.

It has been found in the studies previously mentioned that under the worst possible conditions at the intersection—that is, with all cars stopped—it will take the first car about four seconds after the green appears to get into the intersection. All succeeding vehicles will enter at about a 2-second headway. Allowing these clearance or headway times, ten vehicles per lane per cycle will require $4 + (9 \times 2)$ or 22 seconds of green under the worst conditions to clear through the intersection.

Once a vehicle has entered the intersection, it has the right of way over any other vehicle approaching on another street and may, from the signal timing standpoint, be regarded as having cleared the intersection.[1]

[1] Cf. "Timing Progressive Signal Systems" February and March, 1947, issues of *Traffic Engineering* magazine.

A platoon of vehicles moving through a signal system

Peak hour traffic difficult to handle

Before visibility improvement—curb signals only

After visibility improvement by addition of mast arm signals

Still More Difficult Problems

Some problems the most complex fixed-time traffic signal control system will not adequately handle. The problem may involve an intersection or group of intersections where volumes constantly shift from one street to another or where it is impossible to set up progressive movement to meet all conditions. Under such conditions, traffic-actuated control equipment should be considered. Instead of being confined to a predetermined fixed schedule of timing changes, this equipment is subject to the influence of traffic flow at any particular moment and will adjust length of green periods and cycle length as reflected by the traffic pattern at the time.

An example of this situation can be found in Detroit in what is popularly or unpopularly known as the triangle. This consists of three intersections at the points of a triangle formed by three streets all carrying heavy traffic. The sides of this triangle formed by the inner curbs of these streets average only 200 feet or less. With intersections in such close proximity to each other it is impossible to obtain adequate fixed-time relationships. Volumes carried through this combination of intersections are between 90,000 and 100,000 vehicles a day.

Each of these three intersections is signalized and controlled by a traffic density actuated-controlled. Magnetic detectors are installed in each approach to each intersection located as far as 500 feet from the stop line. No physical or electrical interconnection exists between these three controllers, each depending on the pattern of traffic crossing its detectors to determine the timing of its intervals.

A minimum and a maximum value are set up for each green interval at each intersection and the actual interval length varies between these values according to actual traffic flow. The high volumes at this location are handled in this manner with a minimum number of stops and under normal conditions very little congestion exists. Due to the characteristics of this type of control equipment the controllers tend to fall into step with each other according to the traffic pattern prevalent at the time.

This same type of equipment can be used at locations within a coordinated system which due to spacing cannot be timed for satis-

factory fixed-time, two-way progression. The signal then will tend to fall into step for the prevailing high volume direction.

Signal Visibility

One further matter not concerned with signal timing, but having a bearing on traffic flow, is the visibility of signals to the vehicle driver. If a driver has a good view of signals he is approaching he can do a much more intelligent job of driving. Often by a slight adjustment of speed he can avoid stops and the danger of accidents is reduced.

In most cities with older signal installations, the signals are mounted on pedestals or bracketed from poles at the curb. These indications are becoming more and more difficult to see with the increase in fluorescent advertising signs. The large number of heavy trucks and buses also many times completely obscure the signals at a corner. To overcome this, Detroit has adopted a plan of augmenting the curb signals with others hung over the roadway on mast arms. This places the vehicular signals over the lanes of moving traffic where they can be seen from a considerable distance.

Such practice has proved quite effective as borne out by the following figures. On one major street treated in this manner, rear-end and side-swipe accidents were reduced 31.4 per cent the year after as compared to the year before, and accidents of all types fell 16.6 per cent. Four of the intersections on this street had been on the list of twenty worst accident locations during the year prior to these changes. In the year after, three of them dropped from the list entirely and the fourth fell from seventh to nineteenth place.

If the increasingly heavy vehicle loads are to be handled on our existing street systems, as seems necessary for a number of years to come, advantage will have to be taken of all traffic control devices available in order to provide increased efficiency of movement. This of course will cost money, but if carefully planned, the results will more than justify the expense.

Traffic Planning in San Francisco

HENRY K. EVANS

Mr. Evans is a Resident Engineer of an internationally experienced transportation and engineering firm. He was previously with the traffic engineering division of the National Conservation Bureau and was Director of accident and traffic engineering research, traffic engineering conferences, traffic studies and surveys, and traffic engineering publications. Prior to that he was a traffic engineer for the National Safety Council. In 1942, he was a special employee of the Federal Bureau of Investigation assigned to course development and instruction in war emergency traffic control schools. He is the author of "Wartime Traffic Survey Manual," of "How to Make a Two-Man Business District Parking Survey," and co-editor of a "Manual of Traffic Engineering Studies." He is a member of the Institute of Traffic Engineers, of the American Society of Civil Engineers, of the American Society of Safety Engineers, and of the American Society of Planning Officials.

SAN FRANCISCO did not survive the war unscathed. War production activities increased the population by 30 per cent and the city literally took a beating. Its transit equipment, already in need of replacements before the war, served double duty in the war years. Maintenance of the streets and transportation facilities was reduced to a minimum.

One factor behind this situation was the city's policy during the '30s to avoid any capital expenditures for street improvements and to adhere blindly to the 5-cent streetcar fare long after the time when decent, modern service could be provided for that price.

In 1943, the beginnings of the present traffic planning activity were brought about by the development of the first stages of the present Master Plan as required by the City Charter. In 1946 the City Planning Commission began to work in earnest toward securing Joint action by all city departments toward implementing the transportation section of the Master Plan. Acting on the recommendation of the Commission, the Mayor created a planning council composed of the Chief Administrative Officer, the Public Utilities Commission, the City Planning Commission, and the Police Commission, to

prepare a coordinated program of transportation improvements. The Council, in turn, designated a technical committee to obtain necessary traffic and planning data and work out recommendations. A $200,000 fund was allocated by the city in July of 1947 for a long-range transportation planning program.

The following month a comprehensive report entitled "Traffic, Transit and Thoroughfare Improvements for San Francisco" was published by the Technical Committee that formed the basis for proposals included in the $50,050,000 progress bonds submitted to the voters in the November (1947) election. Local support was gathered for the bond issue by such means as a special exhibit in the City Hall and the distribution of 5,000 copies of a descriptive bulletin designed to explain the plan upon which the bond issue was based.

The bond issue passed by the voters included $22,200,000 for modernization and consolidation of the transit system, $22,850,000 for street reconstruction, including removal of abandoned railway tracks, construction of tunnels, and installation of modern traffic signals, and $5,000,000 to constitute a revolving fund to stimulate the provision of off-street parking facilities.

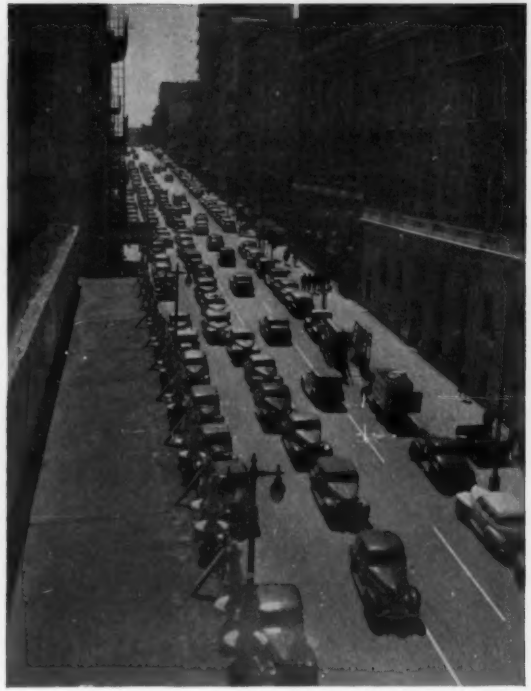
The Planning Project

The traffic planning project was gotten under way actively on November 1, 1947. Two consultants were employed to guide the work of the technical committee and its special staff. An internationally experienced transportation and engineering firm was engaged as transportation consultant. A resident engineer was assigned by the firm to work full-time on the job, and assistance has been given from time to time by other specialists from this firm.

Ladislas Segoe, a city planning consultant, who has been working with the City Planning Commission in the development of its land use plan and new zoning ordinance, was engaged to work with the Technical Committee staff to correlate the development of this plan with the transportation plan. Mr. Segoe also assigned a full-time resident engineer. In special offices made available for this project are assembled a staff of about twenty engineers and draftsmen plus the resident engineer and the staff manager. Field traffic checkers have

Aerial view of San Francisco business district and Bay Bridge, looking east toward Oakland. Market Street is visible in lower right foreground, running approximately parallel to bridge.

One of the old revolving-drum type traffic signals in San Francisco. These are being gradually replaced with modern 3-light type.



Post Street, looking west. An example of inefficient street usage. Where two lanes are used now, three lanes will be used under proposed one-way operation.

been added to the staff from time to time on loan from various city departments. The project was set up to run for one year, with the Technical Committee meeting regularly and closely coordinating the development of the recommendations and plans.

Continuous and close cooperation with the Division of Highways, State Department of Public Works, has been aided through the assignment of an engineer from the city to act as liaison between the City Department, the Planning Staff, and the various City Departments represented on the technical committee.

Four Major Phases

The project deals with four major phases of transportation, namely public transit, trafficways, parking, and traffic control. Various studies have been undertaken by the project staff to obtain traffic data to aid in these four planning phases. A complete cordon count of all vehicles entering and leaving the metropolitan traffic district was conducted with the help of city employees.

Approximately 500,000 vehicles were counted entering and leaving the district in one 12–hour day. Numerous traffic and transit volume counts have been made, as well as accident analyses and speed and delay studies for both transit and automobile traffic. A special questionnaire survey of approximately 20,000 commuters (using Southern Pacific Railroad and Greyhound bus) was conducted in order to determine origins and destinations of trips. A 30 per cent return of the postcards was received, after distributing them to outgoing passengers at the commuter terminals.

Local Transit

The first job tackled was a study of the local transit system, culminating in publication of a report issued in March, 1948, outlining a first stage transit modernization plan. A new routing system was proposed on the overall requirements of the city as a whole, a contrast to the existing competitive duplication of service inherited from former private operators which resulted in overlapping service to some areas and deficient service to others. With the purchase of

the Market Street Railway last year, the city has finally brought about a consolidation of all transit under city management.

The transit modernization plan is based on the standard that areas within one-fourth mile of a transit line, equivalent to a five minute walking distance, will be adequately served. The basic equipment proposed is the trolley bus. Street car travel is to be retained only on Market Street on two tracks instead of the present four, operating through the Twin Peaks Tunnel. Gas buses are to be used only for express service and on crosstown feeder lines. With bond money, 209 new gas buses have been acquired, 50 more are soon to be acquired and 190 trolley coaches are on order. Additional modern street cars will be added too.

Transit Improvements Already Made

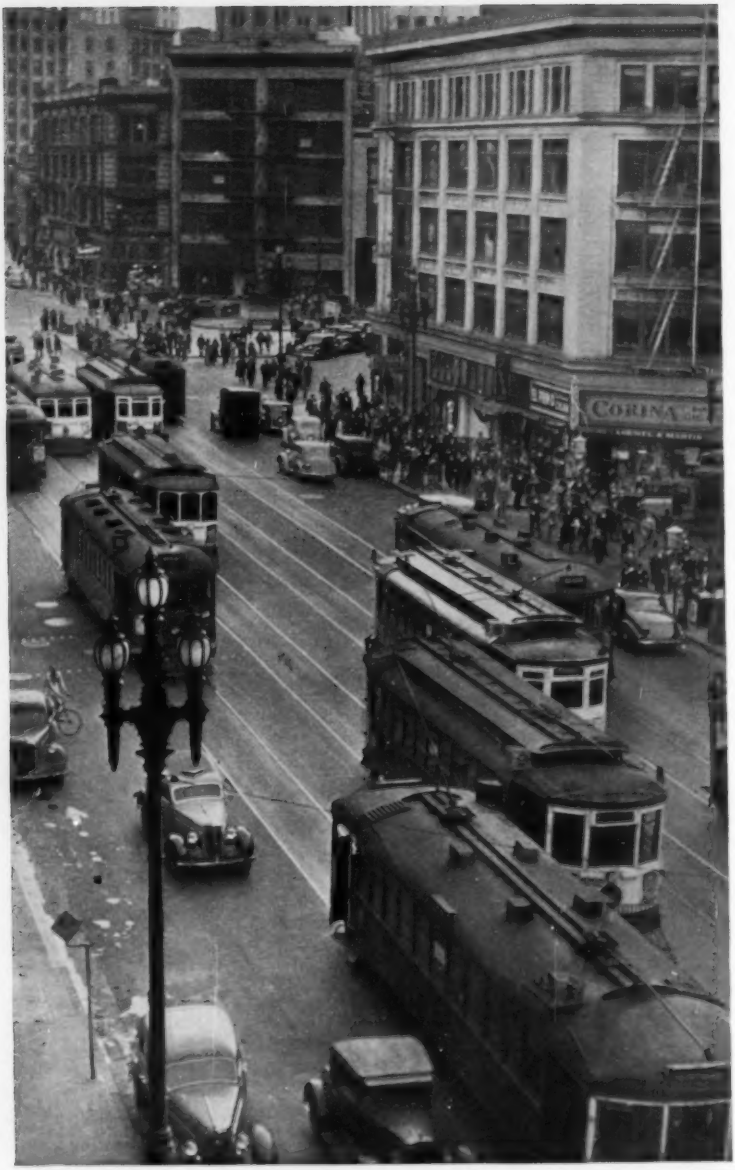
The transit plan incorporated major revisions of service on Market Street, the main business artery in San Francisco. Whereas four street car tracks have existed on Market Street (allowing only two lanes for automobile traffic) the new plan contemplates removing the two outer tracks and substituting trolley coach operation. Also a plan of recommended skip-stops has been adopted along with the abandonment of the outer tracks.

Comparison of speeds in transit vehicles before and after the skip-stop plan showed an increase from 3.8 m.p.h. (before) to 5.4 m.p.h. (after) for street car travel in the peak hour, outbound. Off-peak speeds were increased from an average of 6½ m.p.h. before the change to 7.7 m.p.h. after the change. It is recognized that further reduction in delays will be accomplished when the present traffic signal system is modernized, allowing signals to be timed in accordance with transit vehicle requirements.

An invaluable aid in estimating equipment needs, schedules and locations of routes was provided by the comprehensive origin and destination survey data gathered by the State Highway Division in 1946 and 1947. This was financed jointly by the Federal Government and the State. The Public Roads Administration, the City of San Francisco and other cities within the survey area cooperated in the survey. Utilizing the data on total trips for a sample day, it was pos-

Such scenes as this (on Market Street) were common before suspension of street car operation on two outer tracks this year. Buses have replaced the street cars.

A typical peak hour scene. The new transit plan provides for two seats for every three passengers in peak hour.



Market Street (at Fremont), looking westward. Two outer tracks will be removed shortly.

sible to estimate the total passengers that will ride on proposed transit lines.

Rapid Transit

Plans are now being formulated for a system of bus and street car subways, as well as a rail rapid transit route incorporated in one of the major radial motor expressways. These are planned to terminate in the heart of the business district and provide convenient transfer to the rapid transit facilities that extend over the San Francisco-Oakland Bay Bridge between San Francisco and Oakland. Again, the origin and destination survey has provided a valuable means for estimating the number of subway trains and rapid transit buses needed in the peak hour.

The trafficways phase has involved planning and designing a system of freeways for San Francisco and a plan of major surface routes, to feed the freeways, as well as supplement them. Future location of certain major state routes has been established through state legislation. The trafficways plan has involved the selection of exact routes and interchange points for these contemplated routes, as well as the designation of additional freeway routes. The selection of routes which would serve most effectively the travel desires of motorists was accomplished through an intensive analysis and study of the origin and destination data previously described. Maps showing desire lines were prepared to guide initial trial locations.

Finally, detailed estimates were prepared showing the expected traffic volumes for every proposed expressway, including on and off movements at all interchange points. This work of the allocation of trips to proposed expressways involved investigating the probable routing of travel between every pair of geographic segments in the city, assigning trips to the proposed freeways only when there would be a time saving involved. Much of this analysis was completed through the use of mechanical (punch card) tabulating equipment.

Estimates of travel in 1970 were made, on the basis of the predicted increases in motor vehicle registration and use, and population in each of the geographic segments of the city. The same type of analysis applied also to traffic entering the city from outside points.

The system of freeways established through this analysis consists

of a loop around the business district and four radial routes feeding traffic to the loop. The Loop Freeway will relieve congestion on the downtown streets through carrying much of the present traffic which now crosses directly through the business district, around the periphery of the district, allowing this traffic to feed into the proposed parking areas from the periphery.

Parking

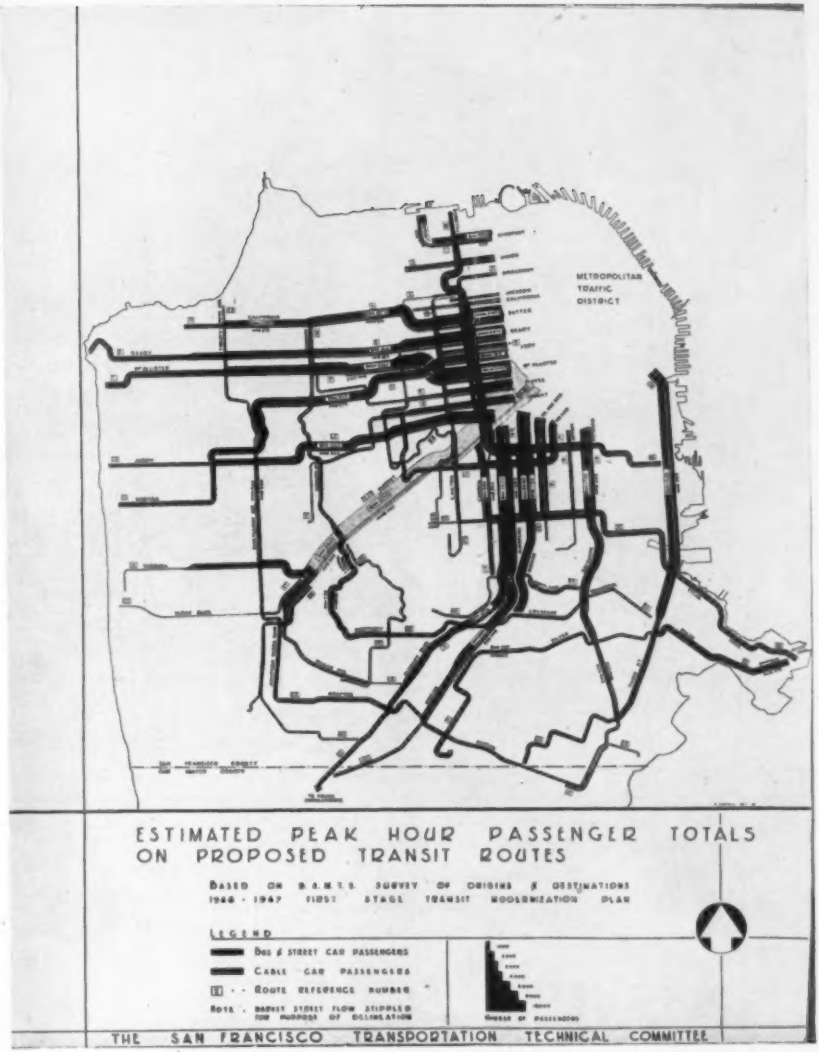
Complete data on supply and demand were gathered. The present supply, in the form of curb spaces and off-street facilities, was found to be less than that determined by surveys of 1927 and 1938, indicating that at least for the central area, parking supply has been superseded by construction of buildings and restriction of curb spaces, while at the same time parking demands have been increasing.

The origin and destination analysis provided a measurement of total parking demand in terms of the ultimate destinations of occupants of parked vehicles. Knowing these destinations, it was possible to compare them with the total supply in the same areas and thereby determine the relationship of demand to supply. In the concentrated part of a business district, it was found that the demand exceeded the supply and that a considerable number of off-street parking spaces are needed in order to provide convenient parking at the points of destination. Knowing these facts has made it possible to establish a program of expanded off-street facilities which will not be grossly inadequate or overly ambitious.

Steps are being taken now to form a parking authority to establish and administer operation of additional off-street parking facilities.

Traffic Control

Many aspects of the problem of controlling street traffic have been investigated. A complete one-way street system has been recommended. This will appreciably reduce the frequency of accidents as well as increase the capacity for traffic movements. Many of the streets in San Francisco are of such width as to afford only two lanes



ESTIMATED PEAK HOUR PASSENGER TOTALS ON PROPOSED TRANSIT ROUTES

BASED ON B.A.R.T.S. SURVEY OF ORIGINS & DESTINATIONS
1948 - 1967 FIRST STAGE TRANSIT MODERNIZATION PLAN

LEGEND

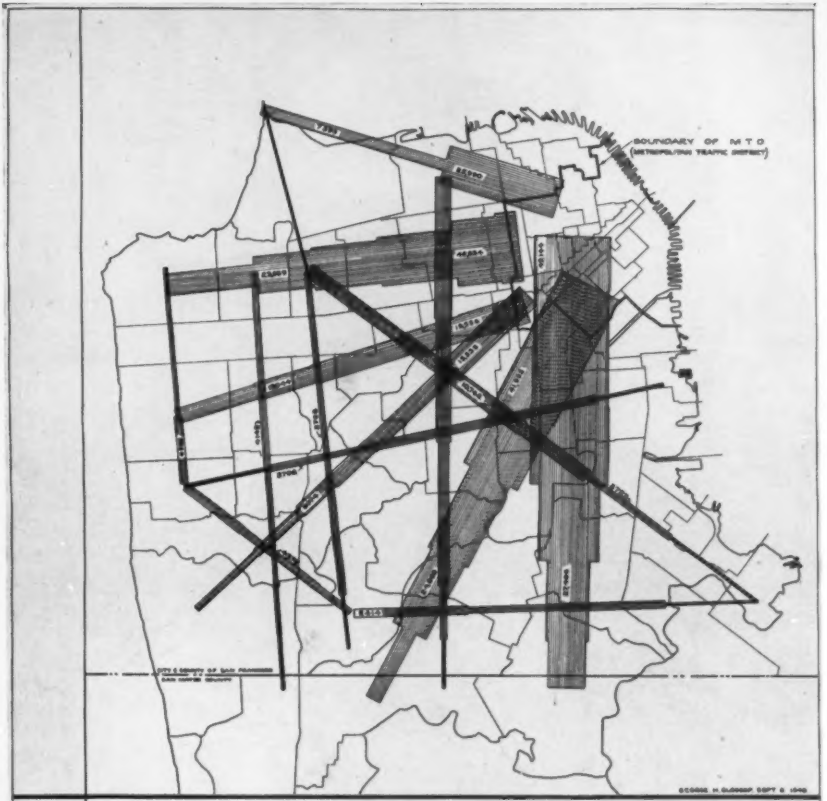
Bus & STREET CAR PASSENGERS

CABLE CAR PASSENGERS

ROUTE REFERENCE NUMBER

NOTE - PEAKEST STREET FLOW STIPPLED FOR PURPOSES OF ILLUSTRATION

THE SAN FRANCISCO TRANSPORTATION TECHNICAL COMMITTEE



MAJOR DESIRE LINES- MOTOR VEHICLE TRIPS

VEHICULAR TRIPS FOR A NORMAL 24-HOUR WEEKDAY BASED ON THE 1946-1947 BAMTS OF ORIGINS & DESTINATIONS.

DESIRE LINE TOTALS SHOWN INCLUDE 78.5% OF GRAND TOTAL OF ALL TRIPS. GRAND TOTAL INCLUDES ALL TRIPS WITH ORIGIN AND/OR DESTINATION IN SAN FRANCISCO EXCEPT TRIPS ENTIRELY WITHIN M T O OR BAY BRIDGE CROSSINGS TO AND FROM M T O.

THE SAN FRANCISCO TRANSPORTATION TECHNICAL COMMITTEE

for traffic movement at present. But these same streets are wide enough to permit three lanes in one direction. In effect, the number of lanes will be increased by 50 per cent. Elimination of left turn conflicts will bring about further increases in street capacity under the one-way plan.

Traffic signal timing was given special consideration. Also forty problem intersections were studied in detail and remedies worked out involving such changes as channelization, street lighting, traffic signal control, prohibition of hazardous parking, and one-way movement.

The local traffic engineering administration set-up was given a full analysis and it was found that there was a definite need for elevating the existing traffic engineering section (of the Department of Public Works) in authority and manpower. There are many activities of a traffic engineering nature now engaged in by the Police Department which should be centralized under the Traffic Engineering Bureau in the Department of Public Works.

What About the Future?

As in many other cities, the dust-laden transportation plans of many decades line the shelves in San Francisco. Some dealt only with transit and others largely with streets and highways. Also there were plans dealing with the parking problem. But none has encompassed the total circulation problem, considering it in relation to land use and the redevelopment of blighted areas, and considering the total movement of people and goods by all methods of transportation. The present planning project is yielding a plan which will meet these requirements, and it is a plan that has been developed by the coordinated efforts of the city departments most interested.

There are therefore, good reasons for believing that the plan now being completed will meet with greater success than previous efforts. The existence of a strong and progressive planning commission, the bond issue passed by voters, and the modernization of the transit system already begun, in line with the first stage plan published in March, are indications of the hoped-for success of this monumental effort.

Utilization of Economic Analysis to Determine Traffic Trends

HARRY H. HEMMINGS

For twenty-six years, Mr. Hemmings, a civil engineer, has been engaged in traffic, city planning and appraisal work with the Regional Plan of New York, Robinson and Steinman, the Metropolitan Life Insurance Company, and as a consultant. He was formerly Chairman of the Traffic Toll Rate Committee of the American Toll Bridge Association, author of one of the prize essays of the Seaman Award for the promotion of safety. He is Adjunct Professor of Civil Engineering at Polytechnic Institute of Brooklyn, New York.

LONG RANGE planning programs have been recommended for the most efficient development of our highways. One of the principal questions is the extent of the increase of the highway pattern. Curves showing the relation between population and motor vehicle registration indicate that the trend of this ratio is rapidly approaching the level stage; that is, that future growth of motor vehicle registration will be influenced largely by population growth.

By the year 1975, the population of the United States will increase about 25 per cent depending on the ratio of fertility, mortality, and immigration used. For medium fertility maximum population is anticipated to occur between 1980 and 1990. Vehicle mileage and gasoline consumption curves show the same general economic fluctuation and a reasonably similar trend of growth as motor vehicle registration.

Since the war, motor vehicle registration and gasoline consumption have surged upward. It shows that people of the United States will again resort to the motor vehicle as a flexible and efficient means of transportation. Motor vehicle registration for 1947 was at an all-time high and within about two and one-half million vehicles of amount predicted for that year by Mr. Robert Whitten.[1] The difference would probably have been smaller had automotive production not been affected by many adverse factors.

The serious urban traffic problem created by the renewed use of

[1] Forecasting Automobile Growth, Robert Whitten, American City, August 1928.

the automobile has been discussed in many ways. State highway departments in cooperation with the Public Roads Administration have made planning surveys, involving more comprehensive work than any previously undertaken because of the Administration's influence. These surveys now include the collection of data on highway location, condition, use, and accidents.

Information relating to the character and efficiency of improvements and the methods of financing a program are included. The recent Master Highway Plan for the Boston Metropolitan Area[2] indicates that planning may be applied to large urban areas. Estimates of the cost of the plan total $322,000,000 and the nation's highway need has been placed at four billion dollars a year.[3]

Traffic Facilities, Improvements Demanded

These two examples alone give some indication of contemplated proposals. This demand for traffic facilities and improvements will continue unabated for some time if the following table is a criteria:

Table 1

GROWTH OF MOTOR VEHICLE REGISTRATION AND POPULATION
(Registration and Population in Millions)

			Families	*Ratio*	
Year	*Motor Vehicle Registration*	*Population*[a]	*Families*[a]	*Persons Per Car*	*Families Per Car*
1930	26.55	122.8	29.90	4.63	1.13
1940	32.03	131.7	34.95	4.11	1.10
1941	34.38	133.2	35.85	3.87	1.04
1947	37.33[b]	142.2	39.10	3.81	1.05
1950	39.30	145.5	40.90	3.70	1.04[c]
1955	41.70	149.8	42.93	3.59	1.03[c]
1960	43.90	153.3	44.78	3.49	1.02[c]
1965	46.00	156.7	46.50[c]	3.39	1.01[c]
1970	48.00	159.8	48.00[c]	3.33	1.00[c]

[a] See medium estimate in "Forecasts of the Population of the U. S. 1945–75" by P. K. Whelpton, U. S. Department of Commerce, Washington, 1947.

[b] Automotive Industries, March 15, 1948, p. 101.

[c] Estimated.

2 Master Highway Plan for the Boston Metropolitan Area, Boston, Mass., 1948.

3 Annual Highway Need of $4 billion Places Emphasis on Planning, G. Donald Kennedy, Engineering News Record, April 29, 1948.

Considering the medium estimate of population and a slightly smaller number of families per car than existed in 1941, it is anticipated that by 1970 the motor vehicle registration will be about 28 per cent greater than in the year 1947, or an approximate average of 1¼ per cent per year.

Projected curves of such data are usually smooth but reference to past growth of motor vehicle registration reveals among others the following:

1. Different stages of growth
2. Effect of depressions

A complete cycle of growth passes through four stages but only the first two will be discussed here as being within the practical limits of this paper.

The first stage is at an increasing rate of increase and the second stage at a decreasing rate of increase. In the first stage, the rate of increase is generally sufficient to overcome the effects of a depression —at most the depression may reduce the rate of increase. But in the second stage, when growth is at a decreasing rate of increase, especially as the maximum value or upper limit of growth is approached, the economic situation exerts greater influence.

These facts have been experienced in the growth of the motor vehicle registration curve. The usual persons per car curve distinctly changed its trend between 1925 and 1930. Lower rates of increase than existed in the previous year occurred in the years 1907, 1913, 1921, and 1927, while actual decreases in motor vehicle registration obtained in the years 1933 and 1938 and, insofar as the war period represents a depression in general motor vehicle production and use, in 1944. The average interval was 6⅔ years.

To some extent, statistics of gasoline consumption per motor vehicle reveal similar effects of economic forces but the influence of the cost per gallon of gasoline clouds the direct effect. Reference to the data[4] develops that the unit annual gasoline consumption per motor vehicle declined in the years 1921, 1932, and 1938. The total fuel demand was less in the years 1932 and 1933.

[4] Automobile Facts and Figures, Automobile Manufacturers Association, Detroit, Michigan, 1946–7.

Such variations in motor vehicle registration, gasoline consumption, and miles traveled are of particular importance in the analysis of the economic justification of various types of improvement. Construction programs financed by funds derived from user taxes may, as in the last depression, be halted.

Similar variations occur in the annual volume of vehicular traffic. In the New York metropolitan area, economic distress barely caused a decline in the aggregate traffic on the Port Authority's three Hudson River crossings but the volume was about 16 per cent below the projected volume of traffic for that year. On the Bear Mountain and Mid-Hudson Bridges the traffic volume declined 26.5 per cent. Other examples are: Carquinez Bridge, 25 per cent; Martinez Benicia Ferry, 31 per cent; Florida Highways, 28 per cent (1926 vs. 1932); Camden Bridge, 12 per cent. As a result of similar reductions in traffic volume, certain toll structures faced periods of financial stress.

Discounting for Economic Fluctuations

Even though the difference in the numerical value of the percentages varies according to the type of traffic, the facility used, the growth stage in the area and the time interval involved, these percentages as well as the past experience with construction programs, emphasize that traffic and user taxes fluctuate considerably.

It is not practical to attempt to project cycle curves for registration, traffic gasoline consumed, etc., but neither is it impractical to discount future motor vehicle usage for anticipated depressions. Past experience may be used to modify the anticipated overall results whether it be for a highway system or a toll facility. With such modification a financial plan may be set up and an orderly construction program outlined. To demonstrate the method of discounting for economic fluctuations, the total state user taxes for the ten-year period 1930–1939 inclusive will be used. These taxes have been reported more accurately by the Public Roads Administration but are rounded out to the nearest million dollars.

The present worth of the tax stream is $4610 or 6.58 times the amount of taxes collected in the initial year. If the user taxes had increased uniformly from $701 in the year 1930 to $833 in 1939,

the equivalent present worth would be $5329, or 7.60 times the user taxes for 1930 and 15.6 per cent greater than the amount shown in Table 2. With usual convex upward curve found in most estimates of trend the present worth would be still greater.

Table 2

STATE USER TAXES—UNITED STATES 1930–1939

Year	User Taxes	Present Worth—(7% basis) Factor[5]	Millions
1930	$701	.935	$ 655
1931	640	.873	559
1932	575	.816	469
1933	498	.763	380
1934	572	.713	408
1935	581	.666	387
1936	654	.623	417
1937	820	.580	477
1938	799	.544	435
1939	833	.508	423
			$4,610

[5] Present Worth Tables:
(a) Highway Bond Calculations—U. S. Department of Agriculture, May 1936.
(b) Principles of Engineering Economy, Eugene L. Grant, Ronald Press, 1943.

With similar information a current problem may be investigated. User taxes for the area in question have previously varied directly with taxes shown in Table 2. The present user taxes available for construction purposes amount to $10,000,000 and ten years hence are estimated to increase to $11,900,000. The present worth of the program based on a uniform increase in user taxes would be $76,000,000 for the entire ten-year period, but by discounting the probable economic fluctuations the present value of the program would be $65,800,000 or 13.4 per cent less.

Therefore a highway construction program based on an estimated uniform increase in user taxes would only be 86.6 per cent completed in the ten-year period unless other funds were made available for construction purposes. Other methods of meeting the neces-

sary funds for completion would require the establishment of a reserve fund or assistance through federal aid.

During the period 1921–1941, federal aid averaged 7.8 per cent of the total road expenditures.[6] To meet the difference indicated above, a 72 per cent increase in federal aid would be required.

Use of the Formula

Highway construction was retarded during the war and current emphasis is to increase the average rate of expenditure. Use of the formula previously indicated should not only develop a program that could be sustained, unless economic conditions proved more severe than in the past; it should also direct greater attention to the economic need for various improvements, the cost of construction, and the dispersion of user taxes.

In the analysis of highway or revenue bond issues, the same principle may be applied, but the period covered would be two to three times that shown above. Toll projects may be similarly analyzed but extreme care must be exercised to discount the effects of competitive facilities unless it is believed that similar conditions will prevail for the new facility as had existed in the past.

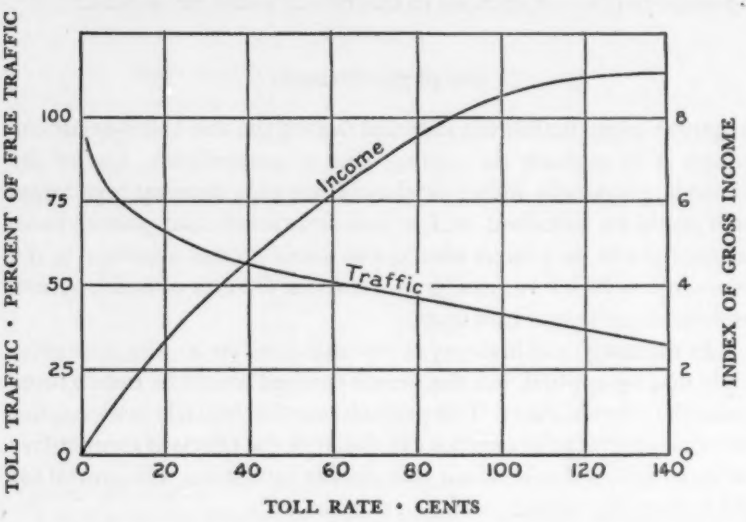
Traffic-toll rate curves are of considerable value not only in the investigation of toll projects but also in highway economics. Early traffic-toll rate curves revealed considerable resistance to tolls but analysis of toll rate changes occurring since the depression show somewhat less resistance thereto. In numerous instances of rate reductions the traffic volume has increased but the total revenue has remained on the same level or has decreased.

Such variations between traffic and toll rates fluctuate not only with economic conditions but also with the type of traffic (through or local), the use of traffic (business or pleasure), the classification of vehicles and also with the extent of competition and the condition of approach roads. Between the initial stage of a depression and its trough a reduction in rate may not result in an increase in traffic and

[6] Highway Development and Financing, National Highway Users Conference, Washington, D. C., 1947.

during the recovery period a similar reduction in rate may result in an excessive increase of traffic.

Similarly on highways a depression may force motorists to disregard the savings in time in favor of the savings in distance. In nor-



mally good times pleasure traffic is not governed by the economic laws that control business traffic and rate reductions do not necessarily have the same influence on the volume of traffic. The attractiveness of the route as well as its condition and the appeal of the point of destination may have a greater influence. The economic forces would apply if two equally attractive routes of different lengths are involved, but with roadways of equal length and attractiveness outbound trips may be made by one route and return trip by the other route.

A typical traffic rate curve and the corresponding revenue curve is shown in the accompanying diagram (Figure 1). These curves apply to routes operating with competitive crossings.

The maximum revenue indicated on the diagram represents gross income and may not coincide with the maximum net income due to the fact that the expense of handling heavier volumes of traffic gen-

erally is greater.[7] On toll structures the expense line may consist of a series of steps as each band of traffic may be handled by a different number of toll collectors. The increasing expense principle operates on a free thoroughfare. Greater traffic will result in greater maintenance costs, increased supervision and may result in an increased exposure to accidents.

The traffic rate curve also has application on free road conditions, where the toll is the cost of operation and the value of the time consumed. While the former expense may be determined readily the latter element—time—is much more difficult to evaluate. The saving of a few minutes may be important to one person and equally unimportant to another. For truck operation the savings may reduce the cost of overtime for some operators while for others the savings will be of real value only if the time saved is of such an amount that an additional trip may be made or more deliveries can be accomplished on the scheduled trips.

Computing the Rate-Curve

From the traffic-toll rate-curve, the percentage of increase or decrease in cost and the corresponding percentage of decrease or increase in traffic may be computed. A reduction in rate from one dollar to fifty cents, in this case, would have a corresponding traffic increase of 25 per cent, but a similar fifty-cent reduction from 75¢ to 25¢ would have a corresponding traffic increase of 35 per cent.

Again, for a 50 per cent reduction in rate from 75¢ to 35¢ the traffic would increase about 18 per cent. It will be noted that for two cases having the same *percentage* reduction in rate, the greater increase in traffic occurs when the reduction affects the higher rate. But as the free traffic end of the curve is reached, a reversal of this law occurs. For a straight reduction of 50¢, the percentage of traffic increase becomes greater as the free traffic end of the curve is reached.

This relation between rate and traffic will explain the "generation" of traffic that occurs when a new facility is opened or an improvement is completed. In each case the improvement means an

[7] The Relation Between Toll Rate and Bridge Income, H. H. Hemmings, American Toll Bridge Association, January 1932.

effective reduction in cost or a saving of time with the result that the facility is used more frequently or is attractive to more motorists. Just as traffic-toll rate curves for toll bridges vary with the character of traffic, competitive facilities, and many other factors, so the use of operating cost and time data will vary under "free traffic" conditions. Traffic on parallel roads, other than that indigenous to the local territory, varies according to the economic cost of operation.

Through-traffic generally follows well posted through-routes. It is not uncommon to find vehicles averaging 10 to 15 miles per hour less than their open country driving speed. While some retardation is due to hills, curves, or weather conditions, most of the reduction in average speed is due to travel through cities and towns. At the same time, the through traffic puts an added burden on municipal traffic regulation and control.

Early highway location was largely a matter of meeting the needs of local areas but as the highway system became more extensive, the development of through routes was undertaken but cities were unwilling to have traffic by-pass routes. Even today the same unwillingness is apparent by the terminal route studies in connection with certain main highways. When such routes are necessary their location should be controlled largely by the local traffic demand so as to be of greatest use to the community.

Where topographical conditions permit, the principal highways should by-pass the central portion of the city but have sufficient entrance and exit roads to permit traffic to transfer to local arterial routes. Such a plan would result in more economical design and land cost. Through traffic would be eliminated or dispersed. The value-destroying vibration of heavy trucking would be considerably reduced. Road maintenance costs would also be segregated more nearly in accordance with the destination of the traffic.

To finance such routes the formula for apportioning road-user taxes developed by H. S. Fairbank of the United States Bureau of Public Roads[8] could be expanded to show separately the relation

[8] A Rational Method for Apportioning Road-User Taxes, H. S. Fairbank, 24th Annual Michigan Highway Conference, Ann Arbor, Michigan, 1938.

See also, Highway Economics by Tucker & Leager, International Textbook Co., Scranton, Pennsylvania, 1942.

between truck highway traffic and total usage of all streets and highways.

In urban and rural areas, today's problem is the allocation of funds for improvement in proportion to motor use. On certain highways, road use is limited due to poor maintenance or the existence of small unimproved sections. With present high construction costs, a special construction and maintenance program to complete and improve a limited number of such highways would provide greater operating efficiency and leave the balance of the funds for the general improvement program.

Traffic Engineering Assistance Is Important to Cities

ARNOLD H. VEY

Mr. Vey has been State Traffic Engineer for the Department of Motor Vehicles, State of New Jersey, since 1930. He is responsible for all traffic engineering work for the state, and he is technical advisor to the Commissioner of Motor Vehicles. Prior to appointment to this New Jersey post, Mr. Vey, as traffic engineer for a firm of consulting engineers in New York, had charge of field work for a survey of the City of Cleveland. He served as chairman of the New Jersey War Transportation Committee, as chairman of the Department of Traffic of the Highway Research Board, and as representative of ITE on the Highway Standards Committee of the American Standards Committee.

RESPONSIBILITY for traffic safety is two-fold—that of government and that of the individual highway user.

It is government's responsibility to establish and maintain leadership in the adoption and application of a balanced accident prevention program. This program should include as far as possible, three basic safety factors: first, the providing of inherently safe highway facilities with modern control measures that will lessen the importance of faulty human behavior; second, constant and adequate enforcement activities to insure the apprehension of those users who fail to abide by the rules of the road, and third, a comprehensive and continual educational program.

The highway user is responsible for conducting himself in accordance with common-sense rules of the road and, equally important, for having a wholesome consideration for the rights of others who use the highways. There is no substitute for individual carefulness and no forgiveness for individual thoughtlessness.

Of the three major elements concerned in the highway accident problem—the user, the vehicle and the highway—the latter two fall in the category of physical conditions and are therefore more readily subject to correction of errors and omissions, or improvements,

through adequate knowledge of such faults and through the application of correctives commensurate with the needs.

It is through engineering activities that the necessity for such improvements may be determined and correctives applied, thereby decreasing the difficulties of human behavior. Improved physical conditions will not necessarily curtail or correct improper actions resulting from faulty human behavior. They will, however, when properly designed and applied, make it less likely for drivers and pedestrians to be involved in accidents.

Streets and highways cannot be designed so they are in all respects foolproof. But past experience has proved factually that properly engineered modern roadways, incorporating up-to-date design features, including controlled rights of way and the physical separation and segregation of traffic, reduce more than one-half of the accidents experienced today.

Similar experiences have likewise shown the favorable effects of properly planned and executed traffic control measures, whether physical, mechanical or restrictive.

Factual Approach

Too many jurisdictions in the past have endeavored—and still are endeavoring—to solve their traffic problems through guesses or opinions, sometimes coached by political expediency rather than by determining official action from facts pertaining to traffic requirements, traffic pattern, accident experience, human behavior factors and others.

It has long been experience that supposed correctives, promulgated and initiated by well-meaning citizens or officials but based on opinion rather than fact, many times have proved not to be the cure-all first believed. Correctives so applied, among other things, often result in confusion and an increase of accidents, with little or no improvement in traffic movement.

An example of such trial and error methods was recently experienced in one of New Jersey's important cities. A section of roadway was changed from a two-way street to a one-way street, next to a one-way street in the opposite direction, and thence back to a two-

way street, all within *one week*. It is needless to describe the motorist's reaction toward traffic authorities responsible.

The only approach to the traffic and accident problem is through the application of engineering methods to the determination and solution of the problem. Such an approach is even more significant and necessary when considering the limited miles of at least partly modern roadways in New Jersey. Of the nearly 28,000 miles of roadway in the State, for example, fewer than 200 miles are of the divided roadway type, and with the exception of short isolated sections, there are, from a practical viewpoint, no miles of modern freeway or parkway type in operation.

For years to come, the major part of New Jersey's present-day urban roadway system will remain the highway transportation facilities of tomorrow. In New Jersey, of the 28,000 miles of road, approximately 94 percent comprise the miles of local municipal and county roadways. This roadway system—under the jurisdiction of counties and municipalities—represents the scene of the majority of accidents and, in concentrated populated areas, is the locale of serious traffic congestion.

To a large extent, these county and municipal roads leave much to be desired in the way of physical features conducive to safe and expeditious movement of traffic. In many instances they are inadequate to meet current traffic volumes. Street intersections are generally at grade and at frequent intervals. Sight distances are often too short for modern speeds. Adequate rights of way are not available for modern design principles nor for demands, both as to moving traffic as well as parking. These and many others are deficiencies of existing city streets.

Despite these shortcomings, however, much can be done to improve existing local traffic congestion and hazards if responsible authorities are willing to attack the problem intelligently and with diligence.

The motor vehicle has improved our general welfare, both economically and socially, but what of the by-products resulting from its increased use—traffic accidents and congestion?

Is it possible, both physically and economically, to lessen the volume and therefore the importance of these by-products, despite

increased highway travel expected in the next few years? It is not alone possible but is a MUST if our cities are to survive as modern, progressive business and industrial areas in which to live and work. The alternative is a choking of the transportation arteries essential for healthy business. This would result in widespread decentralization.

It is possible that decentralization to a moderate degree is not alone inevitable but healthy both for large cities as well as suburban areas. It must affect city ratables and, in turn, adversely affect city living.

Traffic Engineering

From an engineering viewpoint there are two methods of approach to our present-day traffic difficulties; one, the rebuilding of existing inadequate and, in many instances, obsolete roadway systems and, two, the establishment of improved traffic control methods including restrictions on our existing system, commensurate with present and future traffic needs.

The first method, if properly planned and constructed, and sufficiently extensive, is the ultimate. Modern, adequate streets and highways incorporating up-to-date design principles will not only improve traffic expedition but will have a lasting effect upon accidents. Unfortunately, the cost of such construction or reconstruction is prohibitive for extensive near-future application. Economically, therefore, we must be content for many years to come with a limited number of miles of modern improved roadways. To a large extent, these improvements will be confined to trunkline highways between cities rather than extensive and costly rebuilding of city streets within downtown congested areas. True, these planned improvements are essential and will help in the city's overall problem. However, by and large, the city's present-day roadway system, even in congested business areas, will be the roadways of tomorrow.

To deal effectively with the problem of congestion and accidents, therefore, it is essential that each community first organize its responsible forces in a manner to cope effectively with its needs.

The traffic engineer must be a necessary part of these city forces if the problem is to be approached from a factual, scientific view-

point. Traffic engineering is defined by the Institute of Traffic Engineers as:

> That phase of engineering which deals with the planning and geometric design of streets, highways and abutting lands and with traffic operation thereon, as their use is related to the safe, convenient and economic transportation of persons and goods.

Stated briefly, the mission of traffic engineering is to provide adequate and, as far as possible, safe streets and highways suitable for traffic needs or, still more briefly, the expedition of traffic with safety.

How can communities obtain within their means the technical advice necessary to aid in the solution of their traffic problems? At present the major sources of such assistance are:

1. Full-time employment of a traffic engineer within city government.
2. Employment of a traffic consultant on a part-time or job basis.
3. Free consulting service provided by higher levels of government.
4. Free consulting service made available by safety organizations, automobile and insurance groups and other similar organizations.

It is generally agreed that cities above 50,000 in population have sufficient financial resources as well as traffic demand to afford an experienced full-time traffic engineer. Such an official, if given necessary and adequate support, will more than pay his keep in savings resulting from traffic expedition as well as economic gains resulting from accident reduction. This will be accomplished in addition to other tangible as well as intangible savings, all of which enhance the community as a better place in which to live.

Unfortunately, in most states, only a small percentage of communities are above 50,000 in population. In New Jersey, of the 568 municipalities, all of which are incorporated, only slightly more than 2 percent are larger than 50,000 in population. Approximately 24 percent are between 5,000 and 50,000 and the remaining 74 percent are smaller than 5,000 in population.

True, the larger communities have the larger percentage of the state's population and a more or less comparable share of the state's traffic difficulties. Many smaller communities, however, because of their location as suburbs of large cities within large concentrated populated centers or because of major inter-city highways within their boundaries, have more than their share of traffic headaches. The term *headaches* is used advisedly as many times these problems cause considerable difficulty to the smaller community, financially as well as otherwise, without any return.

In such communities, full-time traffic engineering services are not warranted either from a financial point of view or from the viewpoint of large-scale traffic problems. Generally, traffic congestion or hazards are confined to small business centers or isolated locations outside of such centers. All such communities, however, are periodically in need of technical assistance, to the end that such difficulties may be intelligently analyzed and proper correctives applied with the least expenditure.

A practical source of such assistance is the free consulting service provided by higher levels of government. New Jersey, through its State Traffic Engineering Division of the Motor Vehicle Department, has been outstanding in providing such service. Since its inception, this division has made available free consulting service for not only other state departments but to county and municipal governments as well. To some extent, this service is an outgrowth of legislative supervisory control over all traffic not only on state highways but also municipal and county roadways. It is the responsibility of this division to determine, recommend and approve the proper control methods with regard to the design, installation and operation of regulatory devices—signs, signals and markings. In addition, it is the responsibility of the division to investigate and recommend approval of all traffic ordinances regulating and controlling traffic.

Through the conduct of these responsibilities, the division is automatically placed in the position of assisting local governments not only on these problems which come before it for official action but also as consultants on all difficulties relating to congestion and highway hazards.

In addition to providing the necessary technical assistance to

communities, this service is advantageous from other points of view. Through such activities the state authorities have the opportunity to supervise traffic control measures more directly, regardless of political jurisdiction. This creates not only uniform measures but also uniform application and operation.

The improvement of traffic conditions within the state's subdivisions materially benefits the state as a whole in improving general state-wide welfare and in maintaining its municipalities as progressive areas for essential social and business activities. Through such state activities, responsible local officials are able to obtain frequent and quick consulting services for minor as well as major problems. Responsible officials thus receive impartial outside advice many times in answer to complaints and criticisms from constituents whose concept of the problem is often ill advised, narrow and without fact.

Conclusions

Motorists and pedestrians are entitled to roadway facilities that permit reasonably safe use. Since roadways cannot be made foolproof in all respects, it is essential that highway users, both motorists and pedestrians, observe safe practices when using the facilities. But it is likewise essential that responsible officials provide the necessary safeguards to lessen the importance of faulty human behavior. Such safeguards, including up-to-date control methods and traffic restrictions determined and applied as a result of engineering analyses, as well as modern roadway design, where possible and necessary, will improve traffic expedition with safety.

Increases in motor vehicle use will accentuate the problem unless the efficiency of existing streets and highways is improved *now*. Inaction or improper action will seriously affect the economic and social welfare of cities and the state as a whole. State supervision of and assistance in the technical phases of the problem will provide the essential services needed by all cities. In the smaller cities, there is no practical alternative.

Traffic Engineering Can Be Applied To Practical Business Problems

RICHARD GALLAGHER

Mr. Gallagher is a consulting traffic engineer and traffic planner who lives at Ventura, California. He is consultant for several municipalities and private business interests and for the California State Director of Finance. He is reported to have been the first traffic engineer in the West to devote his full time to the private practice of that profession.

A RECENT letter from the head of a large commercial organization contained this typical sense of futility concerning any chance to obtain wholly satisfactory traffic conditions at important business sites: "We try to get the best traffic conditions we can at locations in which we are interested; but if the situation is not as good as we would like, there isn't anything that we, or any surveyor, can do about it."

The purpose of the following article is to show what *can* be done about it.

Relations between business and traffic are fundamental. Business is in business to make a profit. Profit requires customers, and customers make traffic. The more traffic induced, the more congestion is likely. And though business may have tremendous sums invested in property and buildings, excessive congestion will send some of the traffic—hence customers—elsewhere. It behooves business, therefore, to pay particular attention to the scientific factors of traffic.

Part of the trouble lies in the fact that business is not familiar with the methods of collecting data on, and analyzing, the traffic factors that affect it; that is where the traffic engineer can be of assistance.

At first, rather than give in to the building of branch establishments or moving out of the district entirely, business makes a financial investment in an effort to reduce congestion by various methods, dependent upon the size of the city. That this occurs before maxi-

mum use is made of the existing establishments is evident by the fight business puts up.

There is a point of diminishing returns beyond which business cannot go in investing in measures to relieve congestion. Of all the methods of attempting to relieve congestion in the larger cities, the provision of adequate rapid transit should be considered among the first instead of toward the last, as usually is the case.

So Business Goes to the Customer

Business, dependent upon large volumes of customers, and the developers of the new type of neighborhood business districts are demonstrating their awareness of the importance of traffic and parking. This is evidenced by many new developments in several parts of the country in which the locations for development have been selected primarily from the standpoint of ease of traffic-access and parking. The old idea of business *having* to locate in the area with the greatest concentration of persons is well on the way out.

Business is finding that the conditions of congestion encountered by "car" customers in central districts discourage an appreciable percentage of them from making the effort to shop downtown. Add the realization of the general use being made of the private car and the high degree of mobility it affords, and we find business rapidly concluding that it is best for both the customer and itself if it locates in the heart of the area from which it wishes to draw its customers.

In other words, business is tending to go to the customer. This present trend is creating the so-called self-sufficient neighborhoods—which, there seems little doubt, the public desires. These new business districts are more readily accessible and the provision of ample off-street parking is not as costly as in downtown areas.

Business is realizing that even though a particular establishment or group of establishments may be farther away from the origins of some customers, those customers are willing to travel the extra distance if traffic moves more freely and if convenient parking is available.

Finally it is becoming well-recognized that automobile customers are not limited to one shopping center, and that, to get the patronage

of these customers, business has to compete in ease of access and parking *as well* as in smart merchandising. Particularly are larger businesses recognizing this.

Decentralization in itself is not the answer. That is apparent when one considers conditions now existing in, for example, the Miracle Mile on Wilshire. There, not many years ago, it was a pleasure to shop, but the area now has all the earmarks of becoming another congested central district—because adequate provisions for off-street parking were not made as this section developed.

When we talk about the interest of business in traffic factors, parking is foremost in the businessman's mind, for today he has to compete in customer-convenience. The street system, though it may not be adequate, is usually already in place and is a governmental responsibility. Not so is the space in which customers can park their cars.

Responsibility is Three-fold

There are still diehards who say parking is the city's problem, or entirely the businessman's responsibility, or wholly the customer's. But it is more common now to hear that the responsibility rests with all three: with business, due to its incentive for profits; with municipal government, due to its desire to maintain tax receipts without having to spread municipal services unduly; and with the customer, due to his desire for convenience and safety.

In the majority of instances, the main problem in getting action to relieve congestion, and in furnishing adequate off-street parking, is not so much the determination of the various technical factors involved but one of "INERTIA." City officials and business men have a tendency to wait for "the other side" to start the ball rolling.

All this time, economic losses mount higher and higher. One can't expect action from customers because they are not organized, and if conditions get too bad they can shop elsewhere. Therefore, someone from either the businessmen or the city government has to come forth with a definite proposal, call a meeting to thrash it out, and then *keep* calling meetings until a definite plan is agreed upon.

The approach to the matter of traffic and its relation to business in existing and in potential business districts is somewhat different.

In the case of existing districts, it is a matter of determining the most practical, economical ways of alleviating congestion. For potential business areas, the problem is to determine, for each site under consideration, whether or not the contributing street system can accommodate the traffic that will be induced without becoming overloaded. Allowance must be made for future traffic increases. Parking areas must be located so as to cause the least interference to traffic. In other words, the former involves a corrective and the latter a selective approach.

Factors in Selecting Business Sites

The problem of locating a branch of an existing business establishment that already has built up its clientele is not so difficult as that of locating an entirely new business. If a new business is comparatively small and does not have the money to expend on advertising programs and for parking areas, it must usually locate where there already is heavy concentration of persons during the business day—where it will automatically get its required exposure. The larger and more self-sufficient the business, the more it can concentrate on selecting a site which is primarily suitable to the business itself.

Some of the factors necessary to consider in the selection of a business site are:

1. The type of business.
2. Area required for building.
3. Number of employees and customers to be accommodated.
4. The quality or general price range of the merchandise, recreational activity or services offered.
5. Employee travel habits.
6. The income group from which it is desired to draw customers, and the locations of concentrations of people in that income group.
7. Travel habits of customers.
8. Amount of land area available for development, including land for off-street parking.
9. The relationship of the existing street and highway system to the site.

10. The character, volume, speeds, turning movements of existing traffic and the design of the related streets and highways.
11. The availability and use of existing mass transportation facilities and plans for their future development.
12. Plans for future street, highway and freeway construction.

The following are some illustrations of the way in which we have actually applied traffic engineering methods to business problems:

Illustration No. 1

The first example resulted in restaging a development program. A syndicate having acquired a large recreational area, had made preliminary plans to increase the facilities so as to accommodate an addition of ten to fifteen thousand visitors on peak days. They wanted a general check of the traffic situation, including plans for locating new parking areas and for improvements in traffic circulation within the area.

The first thing done was to investigate the peak traffic volumes on the state highway leading into the area and the variation in such volumes over previous years. The results indicated that this highway had been operating at well over its practical capacity for some time and, therefore, that little, if any additional traffic would be induced by such a large, immediate expansion of facilities until additional traffic access facilities were developed. Consequent adjustment of their construction schedule made possible the saving of a considerable sum of money.

Illustration No. 2

Another illustration concerned the proposed new branch of a large retail store. Interviews with employees and customers determined origins and modes of travel. Volume counts were taken and analysis made of the use of the parking area at the main store. The value of the average sale was found and the relative amount of business to be done at the new location was estimated. Investigations were also made of the amount of parking space available and the turnover of space at other comparable establishments. From the above data

the amount of parking area required at the new location was determined.

The amount of space to be devoted to truck terminal facilities was arrived at on the basis of the relationship between those needed at the existing store and its volume of sales as against the expected sales volume at the new place of business. Similar types of merchandise were involved in both cases. Special thought was given to the complete separation of customer and service facilities.

The amount of parking space required necessitated a two-level parking structure. Particular attention was given to the matter of reservoir space in order that customers could get out of their cars and into the store with no delay. Maximum rates of customer arrival were found from volume checks at the main and other comparable stores. This data was adjusted on the basis of floor areas and sales volumes and the required reservoir space determined.

The design of the parking facilities was somewhat complicated by the fact that it was necessary to be able to convert readily from attendant to self parking and vice versa. This involved problems in the economical spacing of columns and other considerations. The topography of the land, which is a very important factor to be considered, lent itself to the favorable development of two level parking.

Consideration was given to the possibility of a third parking level and locations for the necessary additional ramps were planned as well as the effects of the third level upon the two level circulation.

The personal requirements for attendant parking in this case were estimated on the basis of the expected volume of car arrivals, considering of course the amount of reservoir space and how much "stacking up" would be permissible. Also, plans were made to use other methods during peak periods which would permit a reduction in personnel if desired by the client.

Traffic flow characteristics on the adjacent streets were investigated and analyzed. Induced traffic volumes were added to find whether the capacity of the existing street system would be exceeded. In doing this it was necessary to break down the traffic to be induced and assign routes of approach to the store on the basis of origins. This was checked by observations at other stores of similar quality in the

same general area. From this data the turning movements were developed.

Since the surveyors knew the characteristics of existing and induced traffic, they could determine the modifications necessary to the existing street system and traffic signal requirements and timing. Possible effects of future freeway construction were considered and provided for.

Illustration No. 3

The next example illustrates how traffic engineering data can be used in solving some of the problems of major public attractions. In order to obtain data to use in the planning of a new site, studies were made of the attraction during its operation.

Traffic counts were made on the streets and highways affected before and during the attraction to find amount induced by the attraction. Checks were made of both entering and leaving volumes of persons and vehicles. Interviews were obtained from visitors as to their origins, mode of travel and other pertinent information.

From an analysis of this data, supplemented by other necessary studies, it is possible to determine the following for the new site:

1. Best location for site from traffic standpoint.
2. Total area required.
3. The location and design of traffic access facilities.
4. Amount of parking facilities, their location, design and operation.
5. The location, design, operation and scheduling of mass transportation facilities.
6. Number and design of entrance and exit facilities including personnel requirements and working schedules.
7. Pedestrian traffic needs.
8. Locations of buildings and other attractions.
9. Scheduling of events.
10. Publicity planning, locations where advertising should be concentrated.
11. Accommodations required for out-of-town visitors.

The previous examples illustrate a few ways in which traffic engineering can be an aid to business.

Downtown businessmen don't always seem to appreciate the fact that, because of congestion, they are steadily losing customers to small non-coordinated business establishments which are continually springing up outside of central districts. They are usually shaken from their lethargy, however, by the sudden appearance of a large, well planned development in the outer, more convenient portions of the city. This outstanding threat of direct competition usually precipitates rapid action by downtown merchants in attacking their traffic and parking problems.

Businessmen cannot be blamed entirely for downtown congestion as it is within the power of municipal governments to exercise an appreciable amount of control over congestion by the use of zoning for off-street parking.

There is no advantage in either business or government selling traffic "short" for, in traffic, what is best for one usually is best for all in the long run.

Allentown Saves Its Shopping Area

CHARLES S. LECRAW, JR.
Traffic Engineer, Eno Foundation

ALLENTOWN, PENNSYLVANIA, has a shopping center of which it can truly be proud. Extending in the form of a T as shown in Figure 1, this shopping area attracts one-third of a million persons—from as far as 35 miles. Over the years, many improvements have been made. All overhead wires were removed, limitations were placed on the size of marquees, and attractive boulevard lights were installed. Store fronts and display windows were beautified. The result is a shopping center pleasing to the eye, and designed to attract customers.

The problem of providing sufficient space for automobile parking in Allentown's central district was acute before the war. Aggravated by surrounding terrain, that drops off sharply on three sides of the town, the problem involved the providing of parking space in the immediate vicinity of the shopping district. During the war, parking demands dropped sharply. This was due to a 25 per cent decrease in car registrations in the area as well as to the rationing of gasoline. Parking lots in the heart of the city were doing a poor business. Landlords were forced to reduce rental fees on lots, at a time when property values were increasing.

This lull in parking demand, however, proved to a small group of businessmen the seriousness of the city's post-war problem. Accordingly, these civic-minded individuals started a quiet but thorough investigation of the problem.

The first step was to delimit the central shopping district. As in all cities, a "ribbon" type of commercial development can be found extending from the heart of the city. Because of the terrain, this ribbon development is not pronounced in Allentown; and it was decided to devote attention to the area marked in black in Figure 1. The main part of the shopping district extends three blocks along Hamilton Street, with a fourth block along Seventh Street. Based on traffic surveys, a maximum walking distance of 1,000 feet was established, and it was assumed that parking facilities to be effective

must be located within this distance of the shopping district. The area within the 1,000 feet was enclosed on the map, creating an irregular geometric figure, basically elliptical, shown in Figure 1.

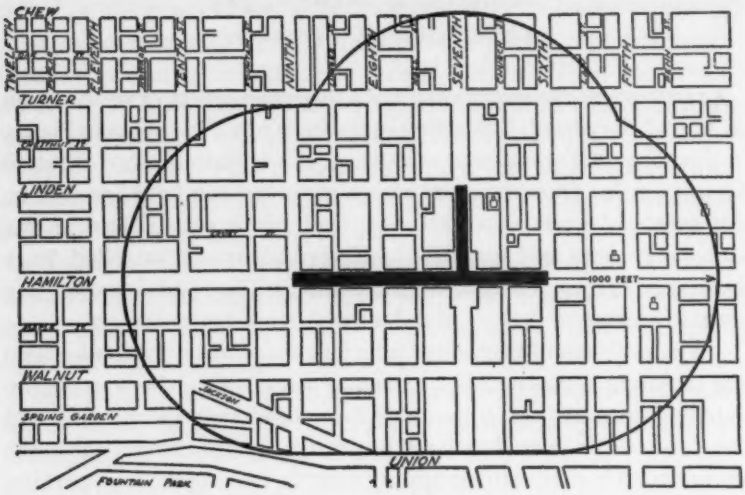


FIGURE 1. Shopping Center of Allentown, Pennsylvania, Showing Area Within 1,000 Foot Radius.

Working quietly, the businessmen investigated land values and rentals, and gathered much important data on properties within this area. Although no formal organization had yet been created, one of the instigators of the idea became so convinced of the soundness of the plan that he personally contracted for the purchase of several areas.

Announcement in 1946 that Sears, Roebuck and Company was moving its big store from the central district to an outlying area proved that immediate action must be taken. Accordingly, four parking lots were purchased and the organization of *Park & Shop, Inc.* was chartered under the laws of Pennsylvania.

OBJECTIVES OF *PARK & SHOP*

The organization depends for successful operation on four major aims:

1. To prevent land now in use for parking from going into other uses. This would assure a nucleus for the proposed chain of lots.

2. To devise a method of operation whereby available lots could be merchandised more efficiently by increasing the turnover of their customers.

3. Acquisition of marginal land that has worn out its usefulness, and the tearing down of buildings that would mean no loss to the city.

4. Better enforcement of curb parking laws so that the 2,000 parking spaces at the curb in the business area could be used more efficiently.

The organization is unique in that it embodies an entire city's business district and its merchants. The corporation is authorized to issue 2500 shares of capital stock at $100 per share for a total capital investment of $250,000.

DETERMINATION OF STOCK QUOTAS

The determination of quotas of stock to be subscribed by various types and sizes of business proves interesting. The quotas are based on two criteria:

1. *Total floor area of first floor,* and

2. *Type of business, with reference to its ability to concentrate sales in a given unit of floor area.* The floors above the first floor were not considered in order to approximate an equalization between stores requiring large storage areas—such as hardware stores—and other stores handling merchandise of a type requiring smaller storage facilities. In considering the second criterion, an attempt was made for adjustment between types of business. For example, a jewelry store was considered able to devote 100 per cent of its first floor area to merchandising, whereas a hardware store was assumed to use approximately 50 per cent of its first floor area for the same purpose.

Using these criteria, the corporation determined the quota for each organization in the shopping district. The minimum quota was established at $300, the maximum quota (already subscribed by a large store) was $40,000. Another large store has already subscribed

its quota of $30,000. At the present time, forty merchants have subscribed stock quotas totaling $141,100. There is a potential membership of 160 merchants, who will subscribe to the total stock issue of $250,000. The plan is receiving support from large and small business organizations in about equal numbers. At the present time, the plan numbers one lawyer among its subscribers, and it is contemplated that other professional offices will be given an opportunity to subscribe to the plan.

FIGURE 2. Engravers Cuts Provided by *Park & Shop* for Use with Advertising by Members.

Figure 2 shows the engraver's cuts provided by *Park & Shop Inc.* for use by participating concerns. Three sizes of cuts are provided and the geometric pattern formed by the 1000 foot radius from the shopping center is emphasized.

SERVICES PROVIDED BY PLAN

Upon subscribing to its allotted quota of stock, a store enters into a contract with the *Park & Shop* corporation. The contract provides that the store may provide free parking for its customers upon lots owned or leased by the corporation, provided the customer makes a minimum purchase of $1. The plan permits a participating store to increase the required purchase before parking is validated by the store. One restaurant requires a minimum purchase of $3 before a customer's ticket is validated.

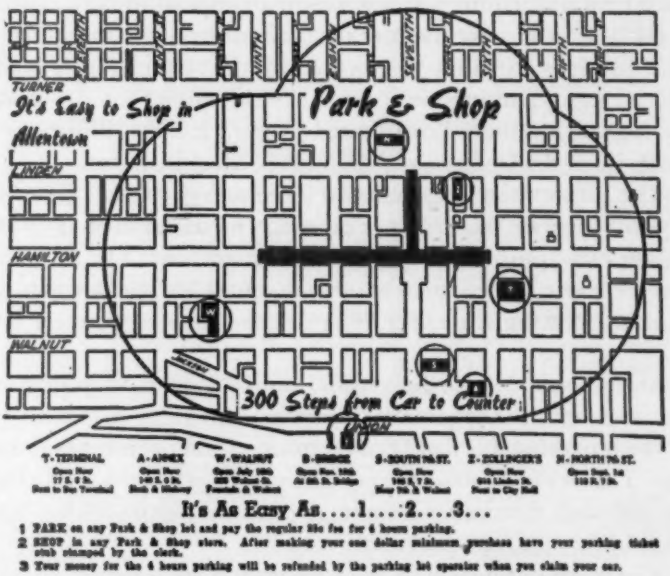

TURNER
It's Easy to Shop in
Allentown
Park & Shop
LINDEN
HAMILTON
WALNUT
300 Steps from Car to Counter
UNION
T-TERMINAL
A-ANNEX
W-WALNUT
S-SWING
S-SOUTH 7th ST.
Z-ZOLLINGER'S
N-NORTH 7th ST.
It's As Easy As....1....2....3...
1 PARK on any Park & Shop lot and pay the regular 10c fee for 4 hours parking.
2 SHOP in any Park & Shop store. After making your one dollar minimum purchase have your parking ticket stub stamped by the clerk.
3 Your money for the 4 hours parking will be refunded by the parking lot operator when you claim your car.

FIGURE 3. Pocket Map Showing Locations of *Park & Shop* Lots.

Figure 3 shows a small map published in folder form to fit into a glove compartment or a pocket-book. Notice that this map shows the location of seven parking areas with the dates of opening for each. This map was issued in the early summer of '47 at the very beginning of the *Park & Shop* plan. Since this date three additional lots have been added to the plan.

The participating store is provided with stamps to be used in validating tickets, window stickers to advertise the store's participation in the plan, and engraver's cuts to be used with newspaper advertising.

PARKING FACILITIES PROVIDED BY PLAN

One of the objectives of *Park & Shop* is to be able to provide a parking facility within 100 yards of any point of entry to the area of influence (1,000 foot radius) of the shopping center. This plan was the basis on which land was acquired. It was almost an impossibility to expect to obtain land within one block of the main street of the shopping center. Therefore attention was focused on the acquisition of land to form a ring of parking lots around the shopping center. Figure 4, showing the lots owned or licensed by *Park & Shop,* illustrates the proximity of the facilities acquired to the ideal locations.

The corporation has purchased seven parcels of land. The highest purchase price was $600 per car space, on the basis of 225 square feet per car—approximately $2.66 per square foot. The seven land parcels contain approximately 150,000 square feet and are valued at $180,000. Parking spaces for 660 cars are provided by these seven lots.

An important factor in considering the *Park & Shop* plan is to remember that the organization purchased several parcels of land on which parking lots had been established and operating for many years. This action assured the permanency of existing parking facilities; and took maximum advantage of community parking habits which build up over a period of years.

The seven lots owned by the corporation are leased to commercial operators. Since the primary purpose of the plan is to provide parking space, the operator is encouraged as much as possible by the feature of very reasonable rental charges. The rule-of-thumb used by the company in determining rentals requires that the lessee pay an annual rental equivalent to 10 per cent of the purchase price of the land. For example, in the case of the lot purchased for $600 per car space, the operator is charged $60 per year per car space. It has been found that this method provides a reasonable rental and thus en-

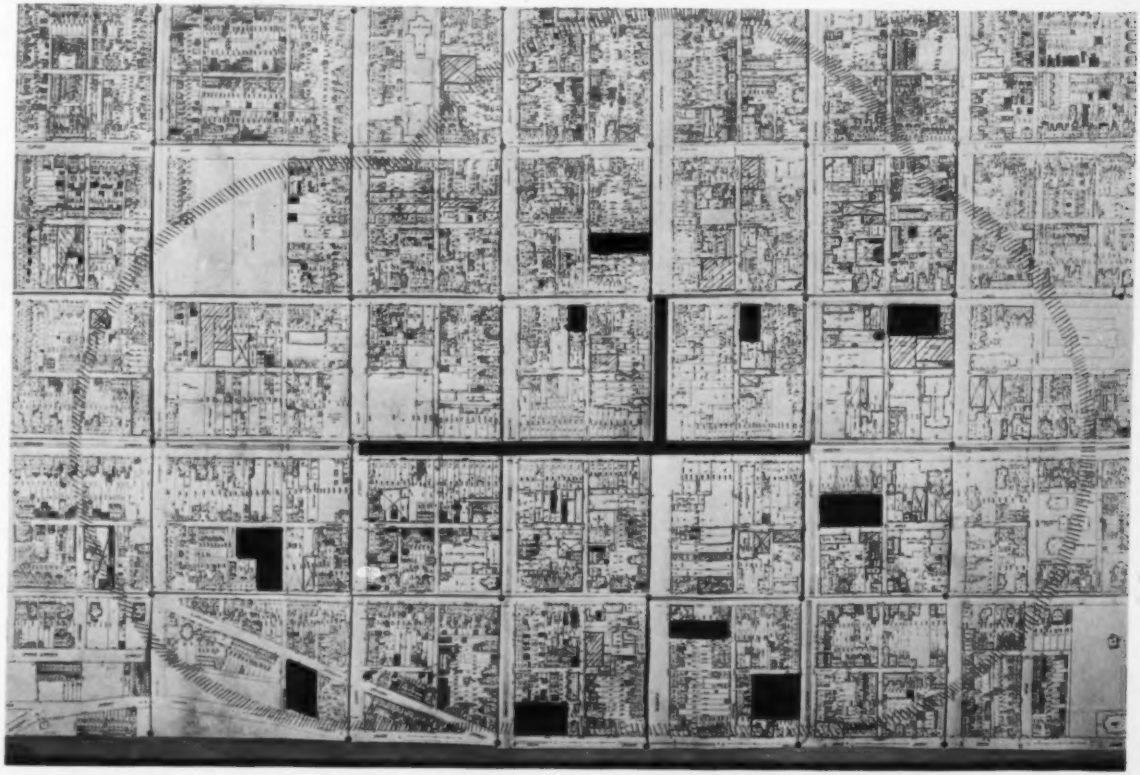


FIGURE 4. Lots Participating in *Park & Shop* Program.

courages the operator to provide efficient service in order to realize a good profit.

Operators are not restricted to handling customers of the participating stores, but may park any motorist. The operator is restricted, however, in the number of monthly contract parkers which may be handled. He is permitted to accommodate contract parkers until the monthly income from this source equals the monthly rental for the lot. This plan has been found to provide a good balance between the provision of spaces for all-day parkers and for short-time parkers.

In addition to the seven lots owned by the *Park & Shop Corporation* three commercial parking lots are licensed to participate in the plan. The lot operator agrees under such a plan to honor parking tickets stamped by any of the participating organizations. *Park & Shop* provides the operator with parking tickets, and erects a very attractive neon sign advertising the participation of the lot in the *Park & Shop* program. The lot operator is free to accommodate other parkers for the regular prevailing fee, the only restriction on his operation being that he must not enter into a contract to provide customer free parking with any organization other than *Park & Shop*.

DETAILS OF OPERATION

Following acquisition of parking facilities, standard tickets and operating procedures were installed at the same time on all participating lots. The timing was important because the lots were in operation independently, and the installation of the plan served to standardize their operating procedures.

When the customer enters a parking lot operated by *Park & Shop*, he is given a standard parking ticket and a fee of twenty-five cents is collected. This fee permits four hours parking. Investigations have proved that shoppers in Allentown wish to park longer than the average shopper. This increased parking time is attributed to the great distances traveled by most shoppers from their homes to the shopping center. Community habit built up over the years shows that the shopper comes to town about once a week and remains a minimum of four hours—and frequently stays eight hours.

Community habit is also responsible for the twenty-five cent

parking fee. Over the years, this fee was charged for all-day parking, and one of the first acts of *Park & Shop* was to reduce the time limit to four hours. Little opposition was encountered in this move, and it is possible for the shopper to secure eight hours free parking by mak-

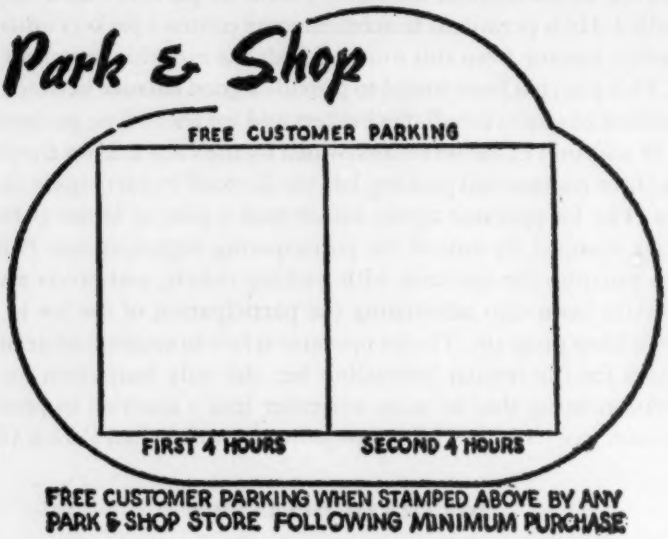

Park & Shop
FREE CUSTOMER PARKING
FIRST 4 HOURS
SECOND 4 HOURS
FREE CUSTOMER PARKING WHEN STAMPED ABOVE BY ANY PARK & SHOP STORE FOLLOWING MINIMUM PURCHASE

FIGURE 5. Reverse Side of Parking Ticket Used by *Park & Shop*. Customer Is Given Free Parking for 4 Hours for Minimum Purchase of One Dollar; May Receive Additional Free Parking for Second Purchase.

ing two purchases. Two spaces are provided on the reverse side of the parking ticket; the store stamps for four or eight hours of free parking. The reverse side of a parking ticket is shown in Figure 5. It is interesting to note that the geometric figure resulting from a layout of the 1,000 foot radius from the shopping center has been adopted as the insignia of *Park & Shop*. Figure 6 shows a window sticker used by each participating member to advertise its membership in the plan.

The customer is allowed to have his ticket stamped by any of the participating organizations, and upon returning to the parking lot, the twenty-five cent parking fee is returned to him. While this sys-

tem of collection and refund requires a double exchange of money between customer and operator, it has been found to work satisfactorily. Advance payment is customary for parkers who will not have tickets stamped for free parking; and advance payment also reduces

FIGURE 6. Window Sticker Used to Advertise Stores' Participation in *Park & Shop*.

to a minimum the possibility of discussion over the right for free parking of a person who entered a participating store for other reasons than to purchase merchandise.

At the end of each month the lot operator sends all stamped tickets to *Park & Shop* and he is paid on the basis of 80 per cent of the prevailing twenty-five cent fee. This reduction of parking fee for *Park & Shop* participants is the only financial concession made by the lot operator, and is more than offset by the amount of publicity given to the lot through its participation in the plan. *Park & Shop* bills each participating organization at the rate of twenty-two cents per ticket stamped by the organization. The additional charge serves to pay the administrative charges of the organization. A careful check made by one store revealed an average purchase of $4.60 by customers using the free parking.

During the twelve-month period from July 1, 1947 to June 30, 1948 approximately 14,000 parking tickets were stamped by member concerns of *Park & Shop*. This represents only about 20 per cent of the total business of the lots participating in the plan. It is believed this percentage will increase steadily until about 50 per cent of a lot's customers take advantage of the free parking offered by *Park & Shop*.

Experience has shown that lots immediately adjacent to participating concerns validate a greater portion of the parking tickets than do lots located at a distance from the member organizations. One store validated 6,100 of the 14,000 tickets stamped during the first year's operation. Of these tickets, 4,100 were from a parking lot immediately in the rear of the store. Other lots of more than double capacity, but located a few hundred feet away, accounted for many fewer tickets.

The provision of parking facilities by merchants for their customers is not a new idea. The Allentown plan has a number of interesting features, however, many of them not in general use elsewhere.

1. Permanence of Plan

Most parking plans have no degree of permanence inasmuch as the land used for parking is normally operated under the terms of a short lease. This permits the land owner to sell the land parcel at any time a profitable arrangement can be made. Such an arrangement usually includes the construction of a large building which not only removes existing parking spaces from the area, but creates a demand for more parking.

In Allentown, however, title to the properties rests with the *Park & Shop* corporation, composed of merchants who realize that the loss of customer parking facilities would provide the first step in the devaluation of their businesses.

2. Future Expansion of Parking Facilities

The *Park & Shop* organization does not feel that its present parking facilities will be adequate for all time. Rather do they foresee a great increase of parking demand in the future. Accordingly care-

ful consideration is given the possibility of expanding the facilities. Before any land parcel is purchased, it is examined carefully from the standpoint of its suitability for the construction of an open-deck parking garage. Minimum dimensions have been decided upon, and any land parcel which cannot meet the requirements for future expansion is not purchased by the corporation.

3. Automotive Services Secondary to Parking

While it is recognized that the provision of automotive services allows the parking lot operator to increase his revenue, the *Park & Shop* corporation has been reluctant to allow operators of its lots to provide such services. Since the entire purpose of *Park & Shop* is to provide convenient *parking* facilities in the downtown district, it is felt that the use of space for automotive servicing will partly defeat this purpose. A compromise has been reached, however, in the case of operators leasing two or more lots from *Park & Shop*. As Figure 4 shows, some lots are within two or three hundred feet of the shopping center, others are nearly a thousand feet away. In the case of an operator leasing a lot of each type, he is allowed to render automotive services at the lot farther away from the shopping center but is not authorized to do so at the nearer lot. The operator is allowed, however, to accept cars for servicing at the nearer lot after which they are sent to the more distant lot to be serviced. Upon completion of the servicing, the cars are returned to the nearer lot and are stored until called for.

Right Turns at Urban Intersections

JACK W. HART

Mr. Hart is a Traffic Research Engineer who recently joined the staff of the Eno Foundation for full-time work in that capacity.

AT URBAN intersections, pedestrians and vehicles must not only be controlled but a happy and efficient relationship must be maintained between them. This must be done with two basically human traffic elements that possess widely divergent operational characteristics. Yet each element has definite rights and privileges in the use of city streets. If these elements, moving simultaneously, maintained their separate ways and did not encroach upon each other's legally allotted areas, there would be no friction between them.

Of necessity and convenience, however, these two traffic streams come together in intersectional areas by vehicular turning movements that encounter a heavy pedestrian stream. A resulting confusion can disrupt the most carefully planned traffic-control scheme and imperil the operational efficiency of that intersection. The sheer weight of pedestrian numbers can block the desired turning movement, or, in instances, the whole following vehicular stream. Likewise, a string of turning vehicles can block a pedestrian stream, preventing the surge of walkers from crossing the street. Conflicts of this nature breed such other undesirable results as accident hazard, transit tie-up, and general irritation. This article, however, deals mainly with the effect on traffic streams. If we can eliminate or alleviate congestion, we shall simultaneously clear up related hazards and hindrances.

Proposing a Plan

This congestive situation of converging streams does not exist at all times. Except at heavily traveled locations, congestion prevails more at some periods than at others—at peak periods in the daily fluctuation of urban traffic. Thus, conflicting movements at intersections do not become a serious problem of delay or congestion until the volume of each traffic component approaches peak-hour level.

The most effective method of regulating this traffic would be one in which regulation is applied only at those peak periods. The system advanced for consideration is one of *selected short-period turn prohibitions.*

Under this method, traffic would be free to flow in the desired paths during periods when these two streams can pass each other freely and safely. During *peak* periods, the pedestrian stream would flow unimpeded while the turning point of the vehicular stream was moved to another intersection. In fairness to all involved, this plan would permit the slower-moving stream that serves the greater number of people to move undisturbed, while the faster stream of fewer units travels the extra distance. This benefits the pedestrian without working to the disadvantage of the motorist. While the motorist cannot turn wherever he may choose, he does turn at the presumably least-congested, most easily negotiated point. Whether this transfer of turning movements creates an even more serious traffic problem, or whether the extra travel required is even more inconvenient, depends upon the judgment of local conditions, or it may be determined factually.

Application of the method would be especially advantageous at locations of short, intense rush-hour congestion, and where there is unwillingness or inability to assume the economic burden of signal or design solutions to the problem. It would provide a second solution to locations that have, in reality, two different traffic considerations at one place.

Facts Needed As a Basis

Periods when turning is prohibited must have a factual basis. Haphazard selection can undo the potential good. A short-time restriction must be a short-time restriction, enforced only in periods of traffic need. When a prohibition functions in periods when turning movements would be safe, simple and quick, the prohibition would serve only as a nuisance. Definitive warrants established from complete investigation are necessary. Many variables must be considered in determining these warrants. And for the warrants to be effective and applicable generally, provision must be made for the variables,

or at least the more important among them. While a problem may be common to many intersections, each intersection may be characterized by its particular form, size, method of control, traffic facility provision. Or, traffic-wise, intersections may vary from strictly the commercial in nature to the strictly private-car with differing flow characteristics.

Ideally, a composite and comprehensive value is needed on which to base a possible warrant. This value should be representative of both traffic components involved, with due regard given those pertinent external factors or variables. The desired value would then be applicable in nearly all instances and locations.

A preliminary study was made using New Haven, Connecticut as the locale. It was done on an experimental basis—primarily studying the right-turns involved. Several measurement values were obtained at selected locations in an effort to determine a satisfactory value or combination of values on which to base possible turning-prohibition warrants. At these locations, only one pedestrian crosswalk was studied together with the turning movements into that crosswalk from the parallel vehicular traffic stream. In all instances, they were four-way intersections with parallel traffic streams moving simultaneously. Initially, these locations were chosen according to apparent pedestrian usage—having primarily either shopper, worker, or college student pedestrian characteristics.

At that time, chiefly volumetric information was gathered. Pedestrian volume on the crosswalk, regardless of direction, and vehicular right and left turning movement volumes into this crosswalk were taken. In an attempt to derive some measure of the congestion involved, right-turning movements, either free-flowing or affected only by pedestrians on the crosswalk, were timed. It was thought that the greater pedestrian volumes would necessitate the turning movement's taking a longer period of time. Neither straight traffic volumes nor the effect of the physical layout of the location were investigated. It was assumed that the previously mentioned values were of primary importance. Left-turning movements were included only on a quantitative basis, representing only ultimate desired turns with no consideration of other factors affecting this vehicular movement.

The Principle Involved

Because of the importance of the time element to this approach—a warrant applicable through needed but comparatively short periods —all data were plotted against a chronological time base. Data for a

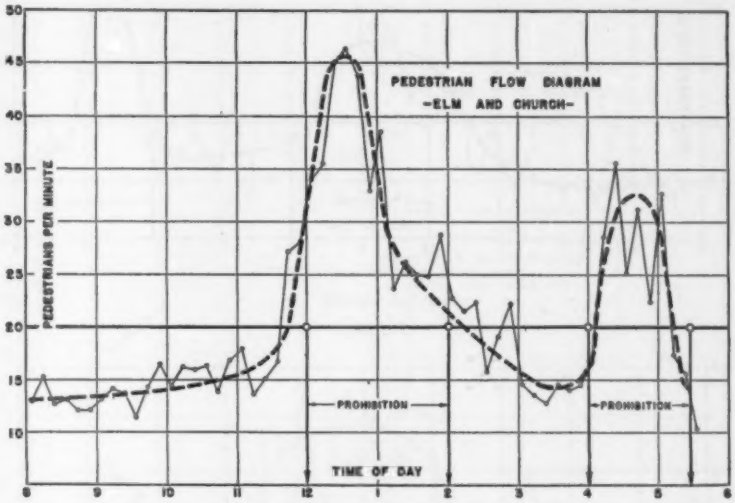


FIGURE 1

full traffic day were gathered. It gave a complete picture of the peak and slump periods for each traffic value observed.

The principle involved originally was that, at one location, data for pedestrian and vehicular traffic would reveal similar peaks and dips, and at the time of the more pronounced peaks, considerable congestion and interference would be observed. Therefore, correlations were sought between pedestrian volumes, turning vehicle volumes, pedestrian-turning vehicle ratios and also turning movement durations in these peak periods.

On the whole, this thesis proved true. These values revealed similar characteristics in that peak-periods generally occurred *at* similar and *over* similar periods. From this, arbitrary limit-lines were drawn to "cut off" these peaks and, simultaneously, to define the

time-bounds for turn restrictions. Thus, with this method, turns would be restricted when pedestrian volumes were greatest, pedestrian per turning vehicle ratios were greatest, and turning movement

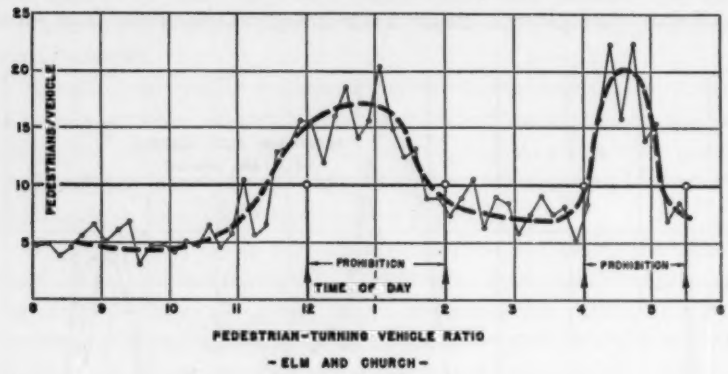


FIGURE 2

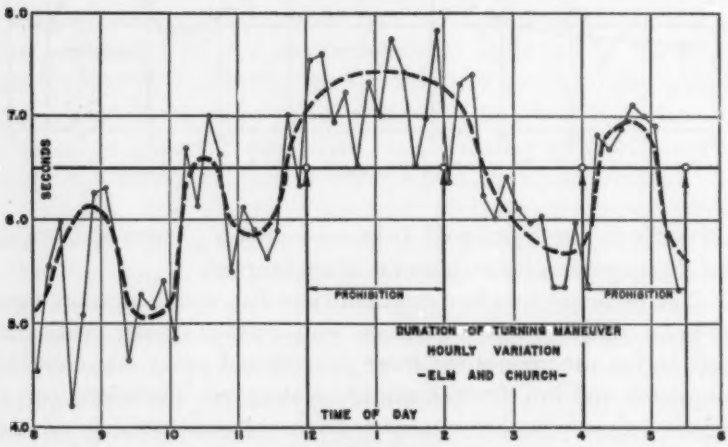


FIGURE 3

durations were longest. Data for one location, shown in Figures 1, 2, and 3 illustrate this point.

This method, while generally accomplishing the desired purpose, proved faulty in a number of instances. The complete study

required at each intersection tended to set up an extensive set of values that would probably be applicable to that location alone. This defeats the purpose of attempting to develop a set of warrants blanketing most intersections of a similar type.

Again, if the type of information required were to be gathered

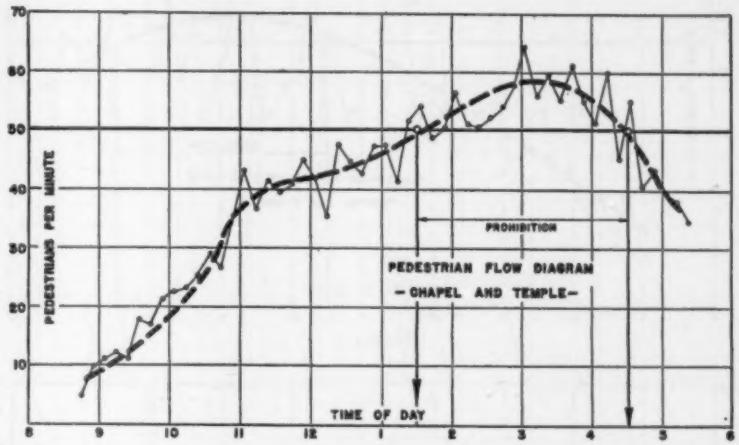


FIGURE 4

by traffic agencies of all types, the indefinite nature of much of it and also the ultimate analysis could be interpreted differently by different agencies. This is especially true in the selection of the controlling limiting lines upon which the whole restriction is based. With peaks not so definitive as these presented, the placement of such a line could be highly controversial.

Finally, the individual values may not give true indications of prevailing conditions at the location studied. Normal behavior and a true representation of desired movements is necessary through both peak and off-peak traffic periods. This can be noted in the case of the pedestrian per turning vehicle ratio wherein the desired number of turning movements, or what would normally be expected, can be altered by a heavy pedestrian stream discouraging this maneuver. This also adversely affects the turning vehicle volumes. The turning movement durations are not sufficiently definitive by them-

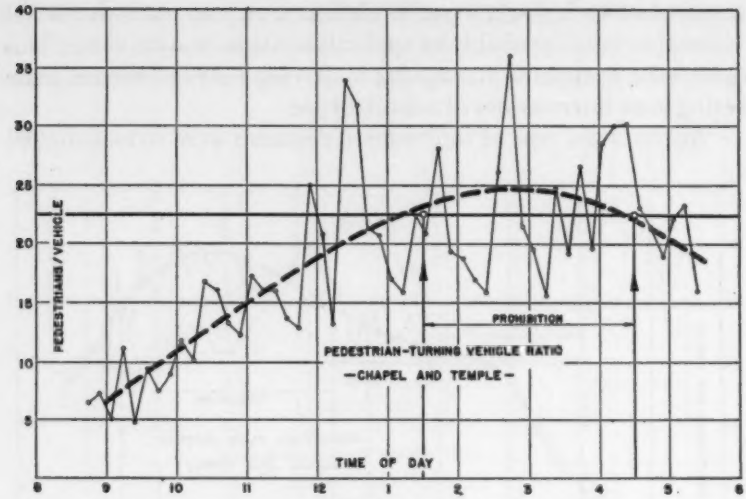


FIGURE 5

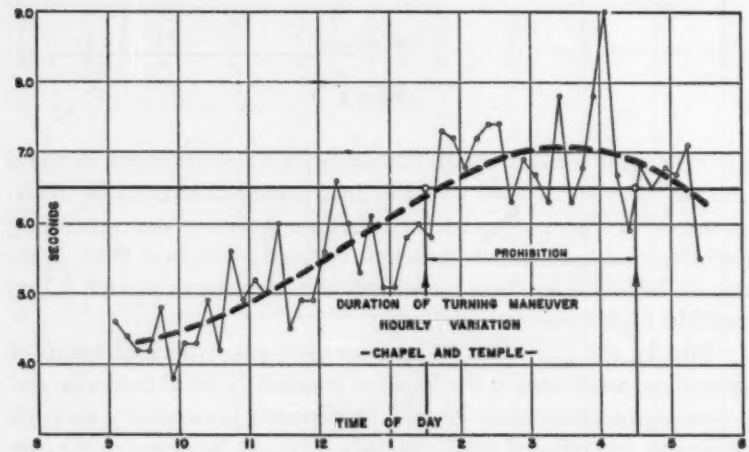


FIGURE 6

selves and are difficult to obtain. Lastly, the truest value left to employ is the pedestrian stream volume, but as previously stated, this value gives no representation to the vehicular traffic stream.

Developing a Single Governing Value

To return to the original thought, it was determined that, if possible, a single governing value should be developed. This single value should be representative of both the pedestrian and the vehicular

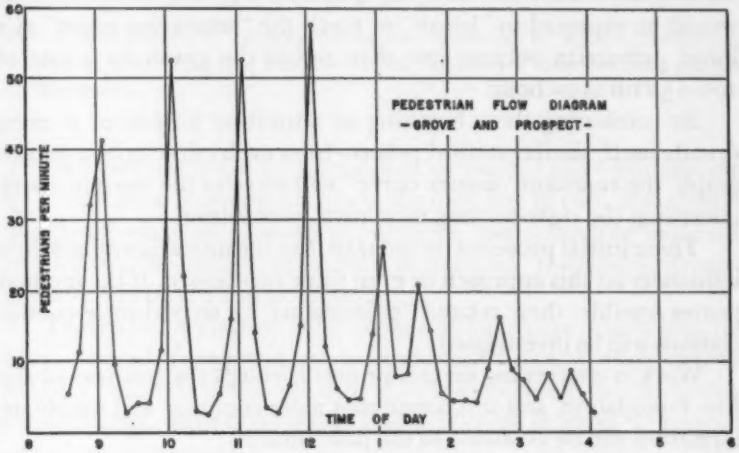


FIGURE 7

streams conflicting in the process of a right-turn maneuver, it should give some indication of the conflict developed, and should be comprised of components easily obtainable to increase the flexibility of the restriction warrant.

The value being developed and utilized at the time of this writing is an "interference" measure—a graphical presentation of hourly pedestrian volume plotted against delayed turning movements or percentage of turning movements delayed. This analysis is in turn controlled by being grouped into turning movement rates on an hourly basis—the vehicular turning rates of 50–100 turns an hour on a different graph from the turning rates of 100–150 turns an hour.

In each of these graphs, as the hourly pedestrian-volume rate increases, delayed turning movements will, in a like manner, increase. In addition, it is believed that each of these curves will reach a "breaking point" or "saturation point," beyond which the turns de-

layed will increase rapidly and out of proportion to the pedestrian volume rates. Also it is believed that this "break" or "saturation point" will occur at a different point on each graph—being determined by the turning movement rate.

Simply stated, with simultaneous pedestrian volume and delayed turning movement increases, the graph for 150–200 turns per hour would be expected to "break" or reach the "saturation point" at a lower pedestrian volume rate than would the graph for a rate of 100–150 turns an hour.

By combining these breaking or saturation points—or if none reveals itself, similar critical points—from each curve onto a master graph, the resultant "master curve" will serve as the warrant curve governing the right-turning movement prohibition.

These initial processes do not take into consideration all possible influences on this approach or even those mentioned. If the method proves feasible, these related "refinements" or second stage considerations will be investigated.

Work is continuing on this project through the courtesy of the Eno Foundation, and it is hoped that more complete and usable information can be available in the near future.

Traffic Design of Parking Garages Discussed in New Foundation Book

A REVIEW

The Traffic Design of Parking Garages by Edmund R. Ricker. Saugatuck, Connecticut: The Eno Foundation for Highway Traffic Control. 184 pp. Illustrated.

CURB parking has to go. Cars stored on needed thoroughfares cut expensive four-lane channels, for instance, in two. Meanwhile, increasing business, growing populations, and constantly more numerous vehicles pour larger streams of traffic on "inadequate streets" to crawl and bump and bottleneck.

These idle cars strewn close to office and store are convenient, for a few. But only for a few. Curb spaces furnish a small part of the total parking facilities in central districts of large cities. In Pittsburgh, Pennsylvania, three-fifths are in lots, a third are in garages.[1] Scarcely a tenth are at the curb.

Unfortunately, curb parking is a habit, a deeply fixed habit, like dumping your golf bag in the hall where Junior trips over it till someone puts it where it belongs before company comes. That is the rub: street-storage *is* convenient; it *is* a habit that's going to be hard to break. Complicated problems plague every attempt to prohibit it.

But street efficiency in modern conditions makes it as senseless a habit as storing trunks in hotel corridors, or empty crates in the delivery entrance of your factory. Buildings fix most street widths. It is the movable barnacles that should be cleaned from street-sides—parked-car barnacles that habit and "due convenience" have crusted on crowded roadways.[2]

The habit can and must be broken. Accessible off-street parking is the answer. With that important function of off-road parking in

1 Smith and LeCraw, "Parking Lot Operation," *Eno Foundation for Highway Traffic Control*, Saugatuck, Conn., 1948.

2 Cf. LeCraw and Smith, "The Prohibition of Curb Parking," *Eno Foundation for Highway Traffic Control*, Saugatuck, Conn., 1948.

mind, the Eno Foundation bestowed a grant upon the Bureau of Highway Traffic of Yale University for the study of traffic design of parking garages. Edmund R. Ricker, a Research Assistant in Transportation, was assigned to the study. The Foundation published his able results in a book entitled, "Traffic Design of Parking Garages." Mr. Ricker, a graduate of the Bureau, had served with the U. S. Army Engineer Board in developing traffic control devices and techniques, and on devices for seeing in the dark.

His book evaluates design features of off-street parking facilities from the viewpoint of traffic engineering. The author presents factual data useful for persons interested in acquiring new facilities or for designers of them. Parking garages are more complicated and more nearly permanent than parking lots. Therefore the author centers his attention primarily on the traffic design of parking garages. Many lot and garage characteristics, however, are similar. Studies of each may be largely interchangeable.

Operating time is highly significant, Mr. Ricker finds. In some of our largest, most modern garages, a customer may wait twenty minutes for his car during times of peak outbound movements. Yet the parking and unparking need total only two-to-five minutes for each car. "This waste is important to the customer," the author writes. "Often a customer withdraws his patronage." Time unnecessarily consumed is also important to the garage operator because it unnecessarily increases his labor cost at the same time it is losing business.

Traffic Design of the Main Floor

Exits and entrances must be placed so that cars may move to and from the traffic on adjacent streets in as little time and with as little confusion as practicable. This aim concerns customers, garage proprietors, and traffic authorities. In determining the number of openings and their location, direct access must be provided to all major traffic streams in strict conformance with local regulations. Entrances should be attractive to customers; exits, safe with respect to passing pedestrians. These openings should be as far as possible from street intersections. Movement in and out of garages is naturally slow. It should therefore be away from congested corners. Stop-and-go lights,

moreover, restrict movement in and out of near-corner openings. This further wastes time.

Some garages have an employee deputized so he may control traffic when necessary to allow cars to leave with minimum confusion. Others depend on municipal police; but this is hard to justify in public expense. Occasionally, left turns have been prohibited because of their interference with other traffic. If this necessitates round-the-block driving from many patrons, structural changes in the garage or the removal of adjacent buildings may be needed. Such waste of time and money can be avoided by efficient arrangement for exits and entrances.

Reservoir space in attendant-parking garages must be large enough to absorb peak flows that exceed the rate at which cars can be stored, the author points out. "Poor layout of ramps and stalls can be overcome by skillful driving," he writes, "and general 'slow design' can be overcome by additional attendants. Elevators and cashiers' cages can be modernized or expanded. But inadequate reservoir space is almost always a fixed liability. Further, the lack of reservoir space breaks down the garage operation during peak demands. Customers are turned away, adjacent streets congested." Thus, this magazine area is the most important in a garage.

The storage rate varies directly with the number of attendants; it varies inversely with the time required to store each car. Thus, the rate of storage per hour equals the number of attendants times sixty, divided by the time in minutes required for an attendant to make a round trip. On an average, the rate of storage must equal or exceed the rate at which cars arrive during the peak period. Reservoir space takes care of spurts that go beyond the average-arrival rate. It also takes care of accumulated cars when attendants, being human, fall below their storing average.

An inadequate reservoir, Mr. Ricker observes, can be partly compensated for by additional attendants. A large reservoir permits fewer attendants. Still, he adds, such adjustments of personnel may prove uneconomical. The problem is to determine the proper-size reservoir for any probable rate of arrival and storage.

No general rule for this proper-size is known. Seven to ten spaces for each hundred of car capacity of the garage is suggested by the

American Automobile Association.[3] Another authority, reports the author, suggests that reservoir space for ten to twelve cars is sufficient for a garage of *any* capacity. Neither of these bases is entirely correct, because reservoir requirements are based on *rates of movement*. A garage with high inbound rates and short-term parking will require a larger reservoir than a garage of equal capacity with a rate of flow that is evenly distributed and low, regardless of capacity.

Distinction must be made between inadequate reservoir space and inadequate garage-capacity. Cars waiting outside an already-filled garage indicate a need for more storage space; cars outside a partly filled garage indicate a lack of reservoir space, a slow rate of storage, or both. When a garage is filled, the reservoir space should also be full. The reservoir is as usable for parking as any other space, when it no longer is needed as a reservoir. If storage space and reservoir are often both full, the garage capacity is inadequate for the demand. In that case, no amount of area designated as reservoir, would be adequate.

Mr. Ricker discusses in detail the application of the theory of probability to reservoir space computations. He explains a rule for determining the required capacity of reservoir space for a particular garage. He discusses reservoir layout and appearance, ramp location on the main floor, and the location of interfloor driver-travel means.

The cashier's cage, interfloor driver-travel means, and reservoir space, it is apparent from this study, are closely inter-related. They should provide short and direct travel paths for attendants. The cashier's cage should be situated conveniently for both customers and attendants. It need occupy but small floor space. Additional accounting for the garage should be done in other offices. The outbound reservoir space must provide multiple delivery points and enough lanes to prevent blocking by undelivered or slow-loading cars.

Customer-parking garages require little reservoir space. They are characterized by a dispersal of activity over the whole garage. In this type of garage, the importance of the main floor is reduced.

[3] "Parking Manual," Traffic Engineering and Safety Department, *American Automobile Association*, Washington, D. C. 1946, p. 134.

The Design of Ramp Systems

Parking demand and land cost in most downtown districts require more storage than can economically be provided on one level. Upper storage floors—or below ground parking—need walls, columns, and ramps. Of these, Mr. Ricker points out, ramps call for the largest area and the most careful planning in location and design.

No single type of ramp is best for all garages. Principal types are discussed in the book. Advantages and disadvantages of each are pointed out. The choice of a ramp for a particular garage can best be made by comparison with other existing garages.

Freight elevators may be used for moving cars between main and storage floors. The principal difference in the use of elevators and ramps is that ramps provide continuous capacity, whereas elevators must operate intermittently. Peak hourly flows of 320 cars an hour would require six elevators. Such flows on the other hand would not tax the capacity of a single ramp system.

One-way ramps are almost always to be preferred to two-way ramps, Mr. Ricker observes, except in very small land parcels. Two-way ramp systems nominally use less space. But wide sections are necessary so cars traveling in opposite directions can meet and pass. While two-way ramps are satisfactory in small garages, the one-way ramp is necessary in large garages to provide capacity for peak movements and to avoid delay and accident.

Clearway ramp systems are specially desirable in garages where customer-parking is allowed. This clearway system has a separate path for vehicles traveling up and a separate path for vehicles traveling down. In this way there is no conflict between parking and unparking movements. Ramp systems by which part of the ramp-travel is done on access aisles may be called the "adjacent parking" type. This type takes less area per car parked because the travel paths have a two-fold use. But consequently more delays occur and there is a greater chance for accident. It is a type that can be used best on small land parcels. Examples of the adjacent-parking ramp system are shown in Figures 2 and 6.

The clearway type provides the safest movement of cars with

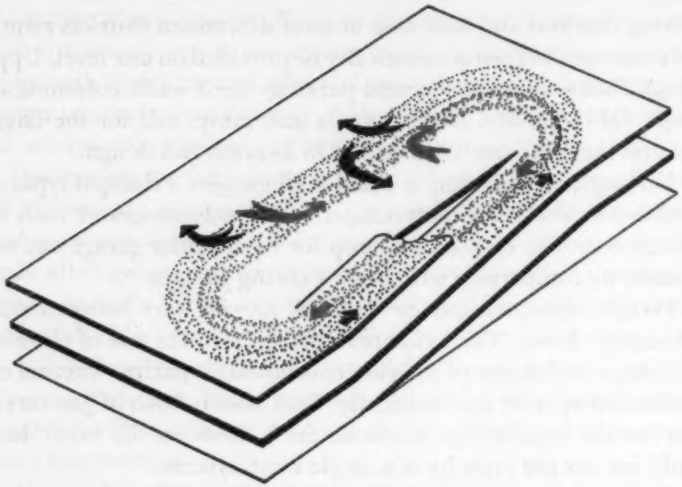


FIGURE 1. Two-way Straight Ramp System

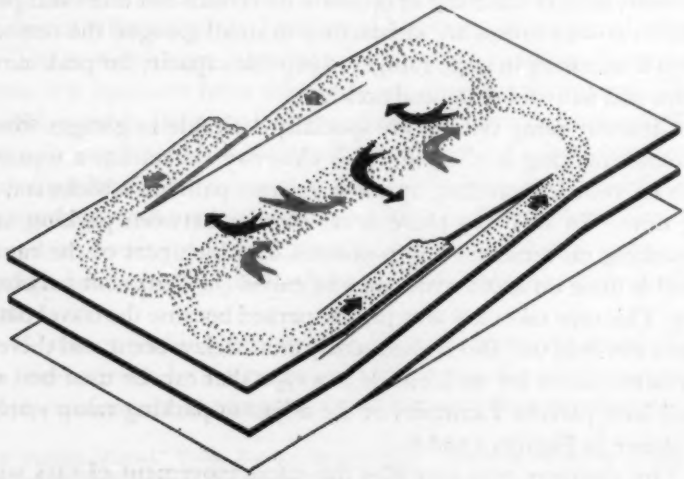


FIGURE 2. Parallel Straight Ramp System

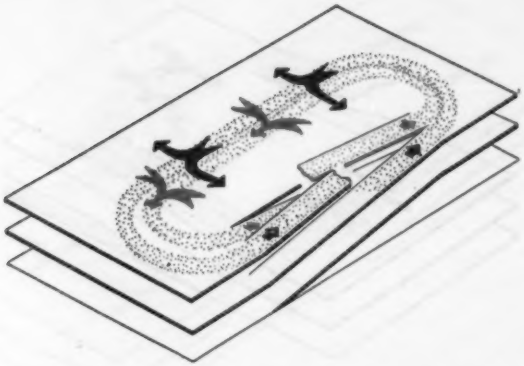


FIGURE 3. Opposed Straight Ramp System, Adjacent Parking Type

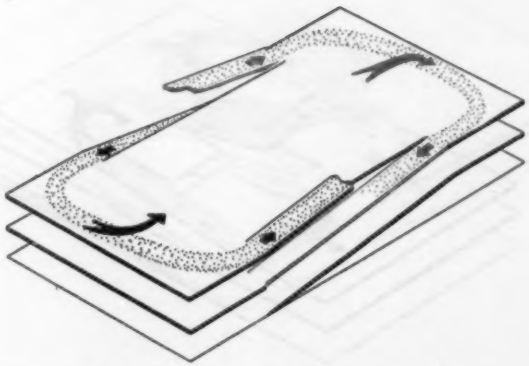


FIGURE 4. Opposed Straight Ramp System, Clearway Type

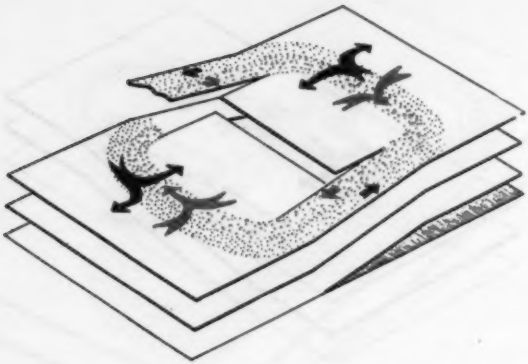


FIGURE 5. Two-way Staggered Floor Ramp System

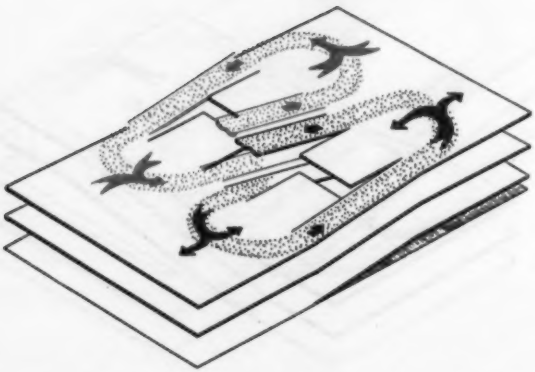


FIGURE 6. One-way Tandem Staggered Floor Ramp System

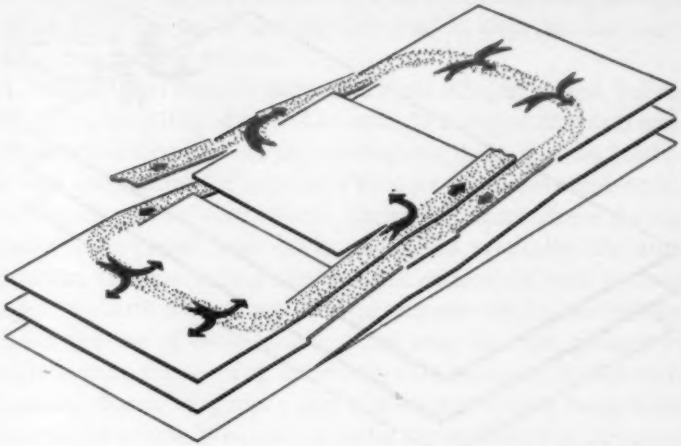


FIGURE 7. Three-level Staggered Floor Ramp System

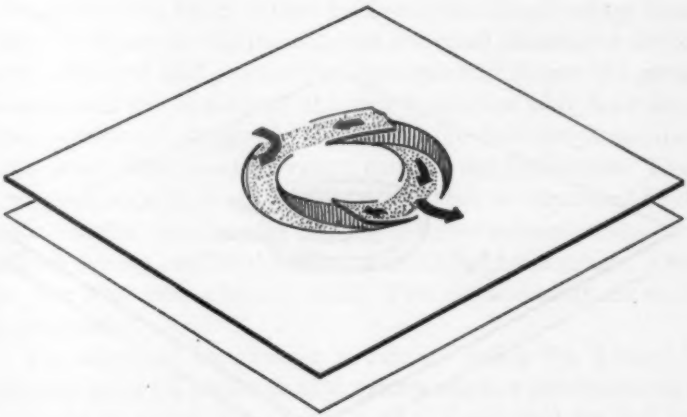


FIGURE 8. Semi-circular Ramp System

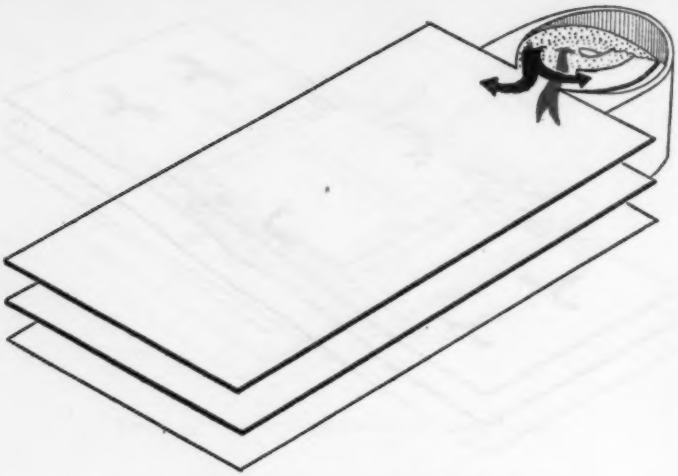


FIGURE 9. Parallel Circular Ramp System

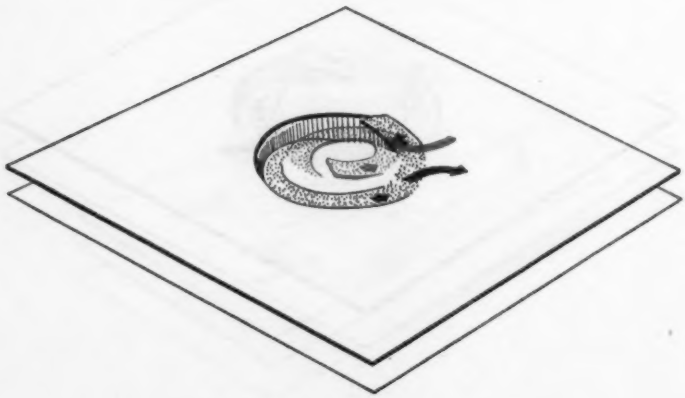


FIGURE 10. Opposed Circular Ramp System

least delay, Mr. Ricker writes; it is much to be preferred for customer-parking garages. The clearway systems, of which Figures 4 and 8 are typical, must be located and oriented in ways that may not be feasible in some land parcels.

Curved ramps require more area than straight ramps, but they allow easier handling of cars. The straight ramp of course is easiest to construct, and it fits into the rectangular shape of most land parcels with least waste. Drivers on a straight ramp have unrestricted view. But they must turn at both top and bottom, where the sight-distance is restricted both horizontally and vertically, the author points out. "Banked curves may be built up into the ends of straight ramps," the author explains, "but cannot provide for smooth turns without the use of considerable extra area. In most garages with straight ramps, the turning movements are made on the flat surface of parking floors." Figures 1 and 7 illustrate several ramp systems with straight ramps. When we consider car stability and driver-comfort, turning movements can be better satisfied by curved ramps because turns can be banked to balance centrifugal force.

Thus, when adequate space is available, a one-way, clearway ramp system with curved alignment is, for efficient operation, probably the most desirable type, the book makes clear.

Staggered-floor ramp systems have considerable advantage on expensive land parcels of unusual shapes and small dimensions. By this system, invented and patented by Fernand E. d'Humy, the garage is constructed in two sections abutting a common wall; floor levels in each section are staggered vertically by one-half story from those in the other. Short straight ramps connect the half-stories. These short ramps slope in alternate directions. They are separated by the distance needed to make easy 180-degree turns between ramps. One section is usually smaller than the other. Called a mezzanine, it contains one aisle and adjacent stalls. Two examples are shown in Figures 5 and 6.

"The staggered floor system of ramps," writes Mr. Ricker, "is applicable to small, high-cost land parcels where a maximum use of space must be made. The construction is simple and fits well into rectangular land parcels. While this system is efficient in terms of floor space per car stall, conflicts arise between cars moving up and

down the ramps and those parking and unparking . . . The amount of bank on the turns can never be sufficient to balance centrifugal force because the portion of the ramp which is parking aisle must be level, or nearly so. These complications make the staggered floor system somewhat unsatisfactory for customer-parking."

A variation of the staggered floor system has three separate levels. Two end sections are at the same elevation and staggered one-half floor from the center section. An example is shown in Figure 7. This requires only half as many turns. It cuts travel time. But the end sections have access to either an up or down ramp only, the author points out, so that each car in these sections must be driven an extra half-floor, either on entering or leaving the parking stalls. In one garage, this caused confusion. Even some experienced drivers had serious accidents in traveling on the wrong ramp.

Also described in the book are semicircular and parallel circular ramps, shown in Figures 8 and 9, and the opposed circular ramp shown in Figure 10.

Layout of Storage Floors

Wrong assumptions in designing early garages include the following:

1. That "the over-all dimensions of cars will not materially change." In some garages where stall size had, on this assumption, been rigidly fixed by columns or other structural features, losses of from one-quarter to one-third capacity have resulted.

2. That "the greater length and width of expensive cars can be discounted somewhat in designing garages because of the much larger number of small cars in use." In some parking garages, however, Mr. Ricker reports, most of the cars parked are of the high-priced class. "Stall, aisle, and ramp dimensions," he writes, "must be based on the kinds of cars that *use* a parking garage, not on the number of various sizes produced." Owners of relatively new cars park them in garages more often than owners of old cars. The most recent model cars, the author concludes, must be given first consideration in designing a parking garage. Allowance must be made for larger makes and models in greater proportion than these models

exist on the road as a whole, especially in the design of garages in high-rent downtown business areas.

3. That "large and small cars can be segregated in stalls of appropriate size." The assumption that a long and a short car can be parked tandem often complicates the parking operation. Sometimes large cars outnumber the large stalls and encroach on the aisles. "Although a few cars of extremely large or small dimensions may be stored in special-size stalls," Mr. Ricker advises, "the majority of stalls should be of standard size, large enough to accommodate all standard makes and models."

Tables and charts clarify the author's full discussion of storage floor layout. He considers future trends, stall length and width, access aisles, unit parking depths, construction details, stall location systems, floor markings and other considerations in storage level design.

Though storage floors should be laid out to accommodate as many cars as possible, an overcrowding is bound to result in inefficient operation, Mr. Ricker warns. To provide for cars that may be built twenty or thirty years from now, he recommends that columns between parking stalls be eliminated wherever possible. The clear span between columns, he suggests, should equal the width of an aisle plus a stall on each side.

Back-in stalls require less total area per car than do drive-in stalls for 90-degree or 60-degree parking. *Drive-in* stalls require less area per car for 45-degree parking. Parking stalls at 90-degree angles to the access aisles require the least total area per car. *Minimum* dimensions for the layout of a storage floor with 90-degree back-in-stalls, Mr. Ricker writes, are:

Stall length	18 feet
Stall width	8 feet for attendant-parking
	8 feet six inches for customer-parking
Aisle width	22 feet
Unit Parking Depth	58 feet

These values, Mr. Ricker explains, are based on the dimensions of 1947 model cars, on the minimum time required for parking and unparking, on theoretical formulas for car movements, and on measurements of current practice by both parkers and garage operators.

Techniques of Operation

Time is the common denominator of all steps in parking garage operation, Mr. Ricker declares. Some of the longest delays measured in his study were due, he says in this book, to faulty operating techniques rather than to physical design.

He discusses procedures for handling cars, the number of attendants and identification tickets. The inter-relationship of garage design and operation is clearly demonstrated, he points out, by the choice of ticketing, by car-handling procedures and by the determination of the number of attendants required.

"A standard procedure for handling cars is necessary for efficient operation," we read. The practice "should cover such items as the sequence of storing and delivering cars, right-of-way rules, and methods of meeting minor emergencies such as unlocated cars and flat tires. The number of attendants employed varies with the parking demand and the unit-time of handling cars. The principal reason for long waiting-periods when customers call for their cars is a shortage of attendants. Identification tickets are among the essentials of garage operation. They provide a receipt for the customer, a means for locating cars, and of accounting-control."

Traffic Considerations

Traffic considerations in parking garages are basically extensions of street-traffic problems. The first traffic problem of the parking garage is perhaps the most difficult—the estimate of parking demand by the public with respect to location, amount, and intensity of use. The most obvious way to get at the demand, Mr. Ricker observes, is to analyze parkers' present habits through a parking survey. Techniques of these surveys have been greatly improved and are widely used. From factual data thus obtained, a garage operator can pretty well evaluate the average walking distance, the destinations of parkers, the rate of incoming and out-going movements, and he can get a pretty accurate measurement of the quantity of additional facilities needed.

"The first aspect of the parking demand to be considered," writes

Mr. Ricker, "is the variation throughout the year. In a given location, the same pattern will probably repeat itself year after year, except as it reflects major social and economic changes. The seasonal pattern has its peak during pre-Christmas shopping. The rest of the annual cycle goes from a low point during the winter months to a secondary peak in the late spring and another low point during the summer period. The 'annual average' line is crossed in March, June, September, and at the end of the year."

The author in a chart illustrates this seasonal variation by months, based on the records of three garages which principally serve shoppers. He further discusses daily and hourly variations, peak rates, theater peaks, evening shopping peaks, and the city-wide parking demand. He considers also the demand and time required for delivering cars, and the movement inside garages.

The most important traffic factors of garages, the author concludes, are the gross amount of parking demand, the time of occurrence of peak movements, the duration of parking, and the rate at which cars can be stored and delivered. Analysis of these characteristics in existing garages makes it possible to measure the efficiency of operation. Average values shown for typical movements can be applied to the analysis of garage design; and a rough estimate can be made of the time that will be required for storage and delivery.

Time required for car delivery, for instance, Mr. Ricker broke down for one garage, as follows:

Obtaining ticket	5 seconds
Walking to service elevator	8 seconds
Riding up service elevator	20 seconds
Walking to stall	45 seconds
Checking location of car	20 seconds
Get in and start	8 seconds
Driving on storage floor	8 seconds
Ramp driving	24 seconds
Average delay on ramps	15 seconds
Driving on main floor	6 seconds
Stop and get out	6 seconds
Delivery to customer	10 seconds
Total time	175 seconds

Storage time for the same garage the author similarly breaks down for a total of 185 seconds.

Conclusions

In a terse and meaty chapter of conclusions, Mr. Ricker summarizes his findings under six divisions: Assessing the parking demand, locating the garage, capacity to be provided, customer versus attendant-parking, general layout, and design standards.

He writes, for example, that in locating the garage, contours of parking-demand should be drawn, and various land parcels rated as to their relative value as potential parking facilities. "A survey should be made of available garage sites," he writes. "Many parcels will be unavailable because of high land values and existing buildings. Others are precluded by cultural conditions such as inviolable monuments, parks, and historic shrines. Some parcels otherwise available may be impractical because of odd shapes or restricted dimensions. Advantageous features of garage sites are these:

A rectangular site
Minimum dimensions, 120 x 120 feet
Location on or near major arterial streets
Location on side of central business toward the origin of most potential parkers
Location allowing main flows of vehicles to arrive and depart by making right-hand turns into and out of the garage
Access on two or more streets
Location on a sloping land parcel, which will allow use of multiple entrances and exits to different levels without ramps

A compromise, the author points out, usually must be made between desirability and availability. But experience shows that a badly located parking garage even if reasonably close to the centers of parking demand may be a failure, both financially and as a solution for the parking problem.

Obviously, more off-street parking *must* be available if decentralization of cities is to be controlled and possibilities of motor transportation realized without impeding the necessary flow of business through curb parking in increasingly crowded areas. Yet such off-

street parking must be attractive to parkers in price, location, and efficiency. And it must be profitable to operators and owners. The importance of a study to help make these objectives possible is shown by the fact that many garages built during the financial and automotive boom of the '20s are not used to capacity, and that some garages have failed financially.

The specific value of Mr. Ricker's study may be suggested by the following summary of his traffic-design standards carefully explained throughout the book:

Entrances and Exits:

Number—single entrances and exits, with multiple lanes, are preferable to several openings.
Location—as far from street intersections as possible, and oriented to favor right turns.
Width of lanes—12 feet

Inbound Reservoir Space

Capacity—based on expected average peak flow.
Lane width—12 feet
Number of lanes—4

Outbound Reservoir Space

Number of lanes—at least 2

Parking Stalls

Type—back-in stalls at right angles to access aisles
Length—18 feet
Width—8 feet for attendant-parking
8 feet 6 inches for customer-parking

Access Aisles

Width—22 feet for stalls at right angles

Construction of Parking Floors

Clear span construction, equal to Unit Parking Depth (58 feet) recommended
Column spacing, when clear span is not practicable, 27 feet 6 inches between column faces
Clear ceiling height—7 feet 6 inches

Ramps

Slope—maximum 15 per cent
Width between curbs
  Straight ramps—minimum 9 feet
  Curved ramps, inside lane—minimum 12 feet
  Curved ramps, outside lane—minimum 10 feet 6 inches
Curvature—minimum radius measured at face of outer curve of inside lane, 30 feet

Curbs

Height—maximum 6 inches
Width—side curbs, minimum 12 inches
Width, center island
  Straight sections minimum 12 inches
  Curved sections minimum 18 inches
Superelevation of Curved Ramps 0.1 to 0.15 foot per foot

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